Offshoring and Specialisation:
Are Industries Moving?

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Abstract

This paper investigates the impact of off-shoring on specialisation via its effect on national endowments and productivity. We use different definition of off-shoring to properly capture international fragmentation of production, while controlling for countries' stocks of R&D and ICT capital. Using industry data for the US, Japan and Europe we show that while off-shoring of materials can benefit a wide range of industries, service and intra-industry off-shoring can decrease specialisation in high-tech industry, both within manufacturing and services. This effect can be compensated with increasing R&D investments.

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1 Introduction

The phenomenon of off-shoring has attracted an increasing interest in the media and in the academic literature. The attention has focused on the pros and cons of off-shoring, particularly in relation to employment and increasing wage differentials (Wood 1995, Hijzen et al. 2005, Bloom et al. 2010). The debate has recently re-heated with the increasing trend in service off-shoring, which is experiencing a fast growth due to the developments of information technologies (Freund and Weinhold 2002).

While the consequences on employment are often at the centre of policy concerns, the impact of off-shoring on countries' specialisation has not been fully assessed. Traditionally, specialisation is driven by economy-wide factor endowments (Heckscher Olin) and (or) sectoral productivity improvements (Ricardo); however, in an environment characterised by increasing globalisation and *'trade-in-tasks'* the traditional theory provides a limited framework. New contributions have developed a rich array of theoretical models but the empirical analysis still lags behind. The main objective of this paper is to use the propositions of neoclassical trade theory to derive a testable framework that accounts for the impact of off-shoring on specialisation via two main mechanisms: an endowment channel and a productivity channel. The former follows Baldwin and Robert-Nicoud (2010) in treating off-shoring as 'shadow migration'. The latter exploits the relationship between off-shoring and productivity (Mitra and Ranjan 2007, Amiti and Wei 2010, Michaels et al. 2010). In both cases we account for the interplay between specialisation and innovation by accounting for the role played by ICT, R&D capital and skilled labour.

The empirical implementation of our model uses industry level data for eight OECD countries (Denmark, Finland, Germany, Italy, Japan, Netherlands, UK and US), observed over the 1990-2005 period. We analyse the impact of off-shoring on two measures of specialisation. Firstly we define specialisation as the ratio of industry output over national GDP, following a general equilibrium framework (see Harrigan (1995, 1997), Redding (2002) and Bournakis and Vecchi (2010), among others). Secondly, we measure specialisation using the Balassa (1965) index of export-based Revealed Comparative Advantage (RCA), which is generally considered to be a more accurate measure of international competitiveness (Amiti, 1999). Our industry data set includes both manufacturing and service industries to provide a comprehensive analysis of the changes in countries' industry structure, as well as to assess how the recent growth in service off-shoring is affecting the structure of this sector[1]. We also use both narrow and broad definitions of off-shoring, including material, services and intra-industry off-shoring (Feenstra and Hanson 1999).

Our results show that material off-shoring is beneficial for the expansion of several industries, including chemicals and electrical equipment; however service and intra-industry off-shoring tend to have a predominant negative effect particularly in highly dynamic industries such as electrical equipment and business services. This negative effect is compensated by a positive impact of R&D stock on specialisation, particularly when R&D is treated as a determinant of productivity. This suggests that off-shoring releases resources that can be directed to innovative tasks, thus fostering countries' ability to compete successfully in the international environment.

The work is structured as follows. Section 2 surveys the main recent contributions on the impact of off-shoring on specialisation and productivity. Section 3 develops our analytical framework and draws the empirical strategy followed in our work. Next, in section 4, we describe our data and present summary statistics. Section 5 and 6 present the main results and discusses their implications. Finally, Section 7 concludes the paper.

2 New trends in international trade: theory and empirics

Countries have always experienced changes in their patterns of specialisation over time and understanding the causes of such changes has been the objective of a long stream of research. The traditional theory focuses on the importance of internal factors, such as endowments and productivity, in driving countries' specialisation and trade flows. Earlier evidence generally confirms the predictions of the classical theory (Harrigan 1997; Nickell et al. 2008). These results have long been considered as supportive of policies towards the accumulation of the right assets, both physical and human, and the adoption of new technologies (Cadot et al. 2007).

The classical framework has been less systematically used to explain the most recent trends in globalisation because of two main limitations. Firstly, it is aimed at explaining patterns of trade in goods, and therefore it is less appropriate to deal with the treatment of cross-country movements of intermediate goods and services (trade-in-tasks) and the integration of production on a global scale. Secondly, it was conceived to describe the role of

[1] Jensen (2008) in assessing the potential implications of trade in high-tech services in the US claims that the service sector is moving towards skill and technology intensive activities, with significant advantages in terms of productivity and employment growth.

traditional factors (productivity and endowments) in international trade and, for this reason, it appeared unfit to provide insights into the impact of innovation on specialisation. To address complexities of modern trade, recent research effort has focused on the development of a suitable theoretical framework. . Grossman and Rossi-Hansberg (2008) provide one of the first rigorous theoretical treatment of off-shoring. Their model considers production as composed of several tasks that can be undertaken inside the firm or in an off-shore location (so-called *trade-in-tasks theory*). Off-shore location is justified by lower factor costs and can involve low skilled or high skilled tasks. Consistently with the theory of comparative advantage, firms will offshore those tasks that can perform less efficiently. The model predicts a positive effect of off-shoring on productivity and on the wages of those workers whose jobs have been transferred abroad, as they are reallocated to more productive tasks. Hence, off-shoring acts as factor augmenting technological progress. Such a rather optimistic view fits well the experience of countries such as Japan that have off-shored labour intensive jobs and relocated workers in specialized highly productive tasks (Baldwin 2006).

An important development by Baldwin and Robert-Nicoud (2010) simplifies the theoretical treatment of off-shoring by integrating the predictions of trade-in-tasks theory into mainstream H-O trade theory, hence into the body of *trade-in-goods theory*. In their setting off-shoring is treated like “shadow migration”, i.e. it is as if foreign factors migrate to the relocating nation but are paid the foreign wages. This implies that off-shoring can be treated as an additional endowment, next to capital and labour. Similarly to Grossman and Rossi-Hansberg (2008), technology in the off-shoring country is superior to that in the foreign country and they consider off-shoring as a source of technological progress for the off-shoring nation (see also Jones and Kierzkowski 1990).

Rodrìguez-Clare (2010) describe a Ricardian economy with unbundling of production tasks, identifying three possible impacts on the off-shoring country: a positive productivity effect, associated with increasing fragmentation; a negative term-of-trade effect on wages,which is prevailing on the short run; and a positive world efficiency effect due to the integration of labor services of low countries into value chains of developed economies. Moreover, off-shoring releases resources that can be allocated to research, thus pushing the technological frontier as previously discussed in Mitra and Rinjan (2007). The latter effects implies that off-shoring also produces dynamic gains, next to the static benefits of the relocation of the less efficient tasks.

Despite the development of a theoretical background for the analysis of the off-shoring effects on productivity and specialisation, the empirical evidence on these issues still is still rather mixed and incomplete. A first strand of studies has looked at the impact of globalisation on the employment prospects of both skilled and unskilled workers (Wood 1995, Feenstra and Hanson 1996, 1999, Bloom et al. 2011, Hijzen et al. 2010) and it has usually emphasised the negative impact of off-shoring on the home country. A second group of works examines the relationship between off-shoring and labour productivity or TFP growth, detecting a positive effect of material off-shoring (Daveri and Jona-Lasinio 2008). In recent years, off-shoring has spread from the manufacturing to the service sector, mainly due to the diffusion of ICT; access to foreign service activities has produced large productivity gains (Crinò, 2008, Amiti and Wei 2010) and, similarly to material off-shoring, it has led to an increases in the relative demand for high and medium skilled workers (Crino' 2011). This evidence is consistent with earlier work by Jensen (2008) which focuses on the role of service off-shoring in increasing the development in high-skill services in the home country and boosting the demand for high-skilled workers. Hence, the evidence provided by Crino' and Jensen suggest that off-shoring has an impact on industry structure within a country, with an increase in the relative importance of skill intensive, high-tech industries and a decrease in the relative share of low-tech sectors, both in manufacturing and services. This view is contradicted by Milberg and Winkler (2010) who claim that resource savings induced by off-shoring does not automatically translate into productivity improvements; indeed, they show that US firms did not invest higher profits enabled by such practices in productive capital, but rather in financial assets.

With the exception of some earlier studies by Saeger (1997) and Rowthorn and Rowasmany (1999), the analysis of the impact of off-shoring on specialization still lacks an adequate empirical investigation. From the contributions reviewed above we can identify two possible mechanisms through which off-shoring can affect specialization: (i) via expanding the sets of factor endowments and (ii) via stimulating efficiency. The reminder of the paper will investigate these two mechanisms, providing a comprehensive treatment of the relationship between off-shoring, innovation and specialization.

3. Analytical framework

Our starting point for analysing the sources of specialisation is within the propositions of the international trade theory. We assume that countries are endowed with a bundle of factor inputs used to produce an array of final goods. Production exhibits constant returns to scale and, at an industry level, firms operate under perfect competition in both product and factor markets. Our theoretical framework follows Dixit and Norman (1980), Harrigan (1997) and Redding and Vera-Martin (2006) and leads to the estimation of Rybczynski elasticities. The latter stress the competitive use of national endowments with an increase in output share in those sectors that use intensively the national abundant factor[2]. The model assumes the following revenue function:

$R_{c,t} = F(P_{ict}, V_{ct})$

where F (.) is the economy *c*'s revenue function including prices of final goods, P_{ict}, and factor endowments, V_{ct}. Subscripts *i* and *t* indexes industry and time, respectively. Given that *c*'s revenue function is continuous and twice differentiable, for a given economy the vector of profit maximizing net output is:

$$r_{c,t} = \frac{\partial f(\cdot)}{\partial p} \tag{2}$$

Harrigan (1997) augments equation (1) with a technological parameter θ, which represents technological differences across industries. This parameter introduces cross-industry differences in a Hicks-neutral manner such as that affect comparative advantage rather than absolute advantage.[3] These cross-industry productivity differences imply that, with the same amount of inputs, industry *i* in country *c* at year *t* is θ times more productive than a reference point[4]. Following this approach, we re-write the revenue function (1) as follows:

$f(\theta_{ct} p_{ct}, v_{ct})$

The way productivity is included in the analysis implies that the effect of technology on output acts similarly to industry-specific prices. Following Woodland (1982) and Kohli (1991) we approximate our revenue function with a second-order translog function:

$$\ln r(\Theta p, V) = a_{00} + \textstyle\sum_i a_{0i} \ln(\theta_i P_i) + \frac{1}{2} \sum_i \sum_k a_{ik} \ln(\theta_i P_i) \ln(\theta_k P_k) + \sum_j b_{0j} \ln V_j +$$
$$12j\mu bj\mu \ln(VjV\mu)+ijcij \ln(\theta iPi) \ln Vj$$

[2] Similarly, the theorem proposes a size reduction in the sector that uses less intensively the abundant factor.
[3] Trefler (1995) models productivity differences adjusting factor endowments in efficiency units affecting absolute rather than comparative advantage as indicated in the original Ricardian framework.
[4] In the construction of the technological parameter, we show that the reference point is an arithmetic mean of all observations included in the sample.

where the summations over i and k run from 1 to K industries (i.e. $i \neq k$), and the summations over j and μ run from 1 to M factor endowments. Symmetry in cross-effects require that $a_{ik} = a_{ki}$ and $b_{j\mu} = b_{\mu j}$ for all i, k, j and μ. Furthermore, linear homogeneity of the revenue function implies that:

$$\sum_i a_{0i} = 1, \sum_i b_{0i} = 1, \sum_k a_{ik} = 0, \sum_j b_{i\mu} = 0, \sum_j b_{ij}.$$

Differentiating (4) with respect to industry price P_i, we obtain the following benchmark Rybczynski equation that determines the share of industry i's value added to GDP as a function of nation-wide factor endowments, prices and technology (time subscripts have been removed for expositional convenience):

$$s_{ic} = a_{0i} + \sum_j c_{ij} \ln V_{jc} + \sum_k a_{ik} \ln P_k + \sum_i a_{ik} \ln \theta_k \tag{5}$$

Equation (5) allows factor accumulation to have different general equilibrium effects across sectors. Precisely, equation (5) implies that an increase in productivity of industry i can cause a decrease in output share of industry k; similarly, an increase in factor endowment V_j will not cause a symmetrical increase of output in all industries. To capture these within-country cross-industry TFP effects we include the average of cross-industry relative productivity, θ. This option is preferred to including every single cross TFP as this would reduce considerably the degrees of freedom in the econometric estimation.[5] Assuming that differences in relative prices can be replaced by a set of time dummies, we arrive at a specification similar to Harrigan (1997) where , industry value added as a proportion of GDP is a function of national factor endowments, own relative total factor productivity (RTFP), and the within country average RTFP:

$$s_{ic} = a_{0i} + \sum_j c_{ijc} \ln V_{jc} + a_{1ic} \ln \theta_{ic} + a_{2ic} \ln \bar{\theta}_{ic} + \varepsilon_{ic}$$

where $\bar{\theta}_{ic} = \frac{1}{n-1} \sum_{x \neq i}^{n-1} \theta_{xi\,c}$ and ε_{ic} is a well error term.

To assess the role of off-shoring, and its interplay with such intangible assets as R&D investment, we consider two possible strategies. One of them is to allow intangible assets and off-shoring to modify the pool of national endowments each industry has access to. The

[5] For econometric purposes such a parsimonious adjustment is almost required without losing the opportunity to test the Rybczynski proposition for the existence of cross-industry productivity effects. See Cadot and Shakurova (2010) for a similar adjustment.

second strategy exploits the relationship between intangible, off-shoring and productivity. In the reminder of the section, we detail the empirical strategy and discuss some important measurement issues concerning specialisation in the global economy.

3.1. Specialisation effects of off-shoring and R&D: Endowment channel

Following Baldwin and Robert-Nicoud (2010), we include international outsourcing into the standard specialisation framework described above. Imports of foreign intermediate inputs, measured as a share of GDP, will be treated as a national endowment of off-shoring; in so doing, we make a distinction between foreign purchases of material and service intermediate inputs. Also, to account for the role of innovations in our setting, we following Bournakis and Vecchi (2010) in accounting for endowments of R&D and ICT capital. Therefore, the empirical counterpart of equation (6) takes the following form:

$$VA_{ic} = \gamma_{1ic} + \gamma_{2i} \ln MOS_c + \gamma_{3i} \ln SOS_c + \gamma_{4i} \ln RD_c + \gamma_{5i} \ln ICT_c + \gamma_{6i} \ln NICT_c +$$

$$+ \gamma_{7i} \ln SK_c + \gamma_{8i} \ln UNSK_c + \gamma_{9i} \ln RTFP_{ic} + \gamma_{10i} \ln AVG\_RTFP_{ic} + \varepsilon_{ic} \tag{7}$$

VA is the industry share on GDP, *MOS* and *SOS* are respectively the economy-wide intensity of material and service off-shoring, *R&D* is the cumulative value of aggregate research expenditure. *ICT* and *NICT* respectively denote national endowment of ICT and non-ICT capital, *SK* and *UNSK* are working age population with high- and intermediate and low-levels of education. *RTFP* is the productivity level of industry *i* in country *c* relative to the cross-country average of the industry; the cross-industry average level of productivity within country *c*, excluding industry *i*, is defined by *AVG_RTFP* .

3.2. Specialisation effects of off-shoring and R&D: Productivity channel

As a further development of our analysis, we assume that productivity is not completely exogenous but it is in part determined by knowledge capital (R&D) and off-shoring. The link between R&D and productivity is well-established in the existing evidence. Typically, R&D is a source of technological advantage, as well as a mean to absorb the knowledge developed by other firms (Cohen and Levinthal, 1989, Griffith et al. 2003, 2004). The relationship between off-shoring and productivity has also been documented in recent contributions (Girma and Görg 2004, Hijzen 2010, Crino' 2009). Therefore we extend our analysis by formulating an expression for productivity as follows:

$$\theta_{i,c} = \Phi(R_{ic}, G_{ic}, \omega_{ic}). \tag{8}$$

The first two arguments within the function Φ are the industry-level value of R&D capital and off-shoring intensity (R and G). ω_{ic} are industry-specific unobserved abilities, assumed constant over time. The impact of off-shoring is assumed to be exponential, $G_{ic} = e^{\sum_z \eta_i^z g_{ic}^z}$, and distinguished between material and services (denoted by z). This implies that one can represent equation (7) in a logarithmic form as:

$$\ln \theta_{ic} = b_{i0} + \beta_i \ln R_{ic} + \sum_z \eta_i^z g_{ic}^z$$

where b_{i0} is a time-invariant term (b_{i0}=ln ω_{ic}).

Substituting equation (9) into equation (6) we obtain the following reduced form specification(time-subscripts omitted for simplicity):[6]

$$s_{ic} = (a_{0i} + b_{0i}) + \sum_j c_{ij} \ln V_{jc} + (a_i \beta_i) \ln R_{ic} + (a_i \sum_z \eta_i^z)\, g_{ic}^z \tag{10}$$

Note that the productivity-enhancing impact of R&D capital and off-shoring, as captured by β_i and $\eta^z{}_{i,}$ has a general equilibrium effect on specialisation through the coefficients α_i. The empirical counterpart of equation 10 equation (eq. 9) is as follows:

$$VA_{ic} = \gamma_{1ic} + \gamma_{2i} \ln NOS_{ic} + \gamma_{3i} \ln MOS_{ic} + \gamma_{4i} \ln SOS_{ic} + \gamma_{5i} \ln RD_{ic} +$$

$$+ \gamma_{6i} \ln ICT_c + \gamma_{7i} \ln ICT_c + \gamma_{8i} \ln SK_c + \gamma_{9i} \ln UNSK_c + \gamma_{10i} \ln AVG\_RTFP_{ic} + \varepsilon_{ic} \tag{11}$$

where $\gamma_{1ic} = a_{i0} + b_{i0,}$ $\gamma_{4i} = a_i \beta_i$ and $\gamma_{zi} = a_i \eta_i^z$ with z=*2, 3 or 4.*

Equation 11 excludes off-shoring as an endowment as well as R&D endowment, i.e. the productivity and the endowment channels are investigated separately. This prevents possible identification problems between the industry efforts in R&D and off-shoring activities and the corresponding national endowments, particularly in high-tech sectors[7]. The difficulty in the evaluation of the relative importance of factor proportion and productivity is a common question in the existing literature, brought up to light by the recent evidence on feedback of productivity on factor accumulation (Doireann and Hallak 2004). A further advantage of our extended framework (eq. 11) is that of controlling for cross-industry heterogeneity in the access to foreign inputs and in the generation of production knowledge that may remain hidden in a regression framework where cross-country differentials are confined to time-invariant fixed effects.

[6] See Yeaple and Golub (2007) for system analysis of specialisation and its determinants like public capital.
[7] For instance, high-tech sectors accounts around for 80% of total business research expenditure in OECD manufacturing (see Sterlacchini and Venturini, 2011).

3.3. Specialisation measurement: GDP shares vs Reveal Comparative Advantage

Although one can easily understand the motivation for outsourcing production activities, the impact of off-shoring on specialisation is not always clear-cut. As discussed above, outsourcing in some parts of the production chain is dictated by the exploitation of lower factor costs but it remains ambiguous how off-shoring affects the trade pattern of the sector. Trade patterns might not be accurately measured by a formulation based on the dual revenue translog function described above. Initially, the sector that uses off-shoring reduces the cost of production and also reduces its size as activities are relocated abroad. However, the sector might also experience improved efficiency and comparative advantage. Therefore, to properly measure the degree of international competition, as a robustness check of our prior results, we measure specialization with the Balassa index of revealed comparative advantage based on export flows:

$$RCA = \frac{x_{ic}}{x_c} \Big/ \frac{x_{iw}}{x_w}$$

When using the RCA-index one should be aware that its dynamics reflect both changes in relative export specialisation of the sector (the numerator) and in country-wide competitiveness (the denominator). When the latter worsens or improves quite rapidly with respect to the numerator, the RCA-index might provide counterfactual information on real trends in industry-level competitiveness (De Benedictis and Tamberi, 2004). Moreover, RCA-index is heavily influenced by movements in international competitiveness of over-specialized sectors (i.e. those with RCA well above the unity). Finally, the skewness of RCA distribution (increasing with the level of data disaggregation) and the time-variancy of RCA mean might inhibit inference based on the classic linear hypothesis.[8] We leave exploration of our findings to the issues related to the RCA nature for further research.

4. Data sources

The empirical analysis is based on a sample of 17 industries (12 Manufacturing industries and 5 Service industries) for US, Japan and six EU countries (Denmark, Finland, Germany, Italy, Netherlands and UK). To perform our analysis we use a set of industry level as well as national level data. Most of the industry level data on output and productivity are derived

[8] Proudman and Redding (2002) propose a correction to RCA-index to neutralize such plagues.

from the EUKLEMS data base. Data on labour endowments, classified according to three groups of educational levels, come from the Barro-Lee (2001) data set. R&D data is derived from various versions of OECD ANBERD and Science and Technology database. By national endowment of R&D, we mean total business R&D (BERD).

Our measure of Hicks-neutral technology is Total Factor Productivity index, A. The construction of this index follows the methodology suggested by Caves et al. (1982), van Ark and Pilat (1993) and Harrigan (1999). The derivation of this index is based on the assumption that value added is produced by two heterogeneous inputs, labour (*L*), and capital (*K*). The methodology adopted in this analysis accounts for differences in quantity and quality of the inputs in the different countries. The current measure of TFP is based on the standard neoclassical assumptions of perfect competition and constant returns to scale. TFP in each country is expressed relative to a hypothetical frontier or reference country. The latter is the average level of TFP in the eight countries in each industry. Assuming a Cobb-Douglas production technology, for each industry *i* of country *c* at year *t*, the production function is as follows:

$$Y_{c,i,t} = A_{c,i,t} L^{\alpha}_{c,i,t} K^{1-\alpha}_{c,i,t} \tag{11}$$

We define the production function of the reference country as:

$$\bar{Y}_{i,t} = \bar{A}_{i,t} \bar{L}^{\alpha}_{i,t} \bar{K}^{1-\alpha}_{i,t} \tag{12}$$

The bar over a variable indicates the geometric average of all observations in an individual industry *i* for year *t*. Therefore, the logarithmic expression of RTFP (relative total factor productivity) is given by:

$$\log RTFP_{c,i,t} = \left(\log Y_{c,it} - \log \bar{Y}_{i,t}\right) -$$

$$\bar{\sigma}_{c,i,t}\left(\log L_{c,it} - \log \bar{L}_{i,t}\right) - (1 - \bar{\sigma}_{c,i,t})\left(\log K_{c,it} - \log \bar{K}_{i,t}\right) \tag{13}$$

The labour share α is measured as the ratio of labour compensation to value added. The weighted variable $\bar{\sigma}_{c,i,t} = (\alpha_{c,i,t} + \bar{\alpha}_{c,i,t})/2$ is the labour share's arithmetic mean of all observations in industry *i* at year *t*.

The EU-KLEMS database from the Groningen Growth and Development Centre (GGDC) is the main data provider for the construction of TFP. To obtain a meaningful measure of RTFP, we convert value added, labour and capital compensation and investment in capital assets into international US Dollars using the GDP purchasing power parity (PPP) exchange rate reported by the World Bank Development Indicators - International Comparison Project (ICP).[9] Finally, we express all values in 1995 constant prices using the industry price deflators of the EU-KLEMS data base. Labour input in equation (12) accounts for heterogeneous labour by aggregating three types of workers identified according to their educational attainment (low skill, intermediate skill, and high skill)[10], weighted by the share of each type of in total labour compensation. Similarly the construction of the capital stock is obtained by aggregating ICT and non-ICT assets, weighted by the share of each asset in total capital compensation[11].

Our indicators of international outsourcing (off-shoring) intensity at an industry level are built following the common practice originally proposed by by Feenstra and Hanson (1999, 2003):

$$TOS_{c,i,t} = III_{c,i,t}/NE_{c,i,t} = \sum_{j=1}^{K}(III_{c,i,t}^{j})/NE_{c,i,t} \tag{14}$$

where $III_{c,i,t}$ are imported intermediate inputs, $NE_{c,i,t}$ total purchases of non-energy inputs (materials and services) by industry i at time t on both the domestic and foreign markets. When a full set of Input-Output matrices is available, $III_{c,i,t}$ can be extracted from the import matrix, $NE_{c,i,t}$ from the use matrix. When IO matrices are not available on a yearly base, $III_{c,i,t}$ can be estimated as follows under a "proportionality" hypothesis (assuming only one tradable good):

$$III_{c,i,t} = \tau_{i,b}\, III_{c,t} = \; (III_{c,i,b}/III_{c,b}) \times \; III_{c,t} \; . \tag{15}$$

$III_{c,t}$ are total (economy-wide) imports of the tradable good (available on a regular base), which are multiplied by the share of industry i on total (economy-wide) imports in a benchmark year b. $\tau_{c,b}$ is given by the ratio between $III_{c,i,b}$ and $III_{c,b}$ which are taken from the available IO matrix at the benchmark years, b=1995, 2000 and 2005. For missing intermediate years, τ is linearly interpolated, while values for the pre-1995 period are backwardly extrapolated from the levels of 1995 by applying the changes of rate of the period

[9] There are limitations with the use of a GDP PPP-exchange rate conversion method if one takes into account that prices differ across sectors in the economy. Provided that PPP-exchange rates for a disaggregate industry level are not available for a long time series, we believe that the method used is the best alternative.

[10] The division of labour according to the level of educational attainment can cause some problems as the educational system has been subject to changes over time. The method used from EU-KLEMS ensures that this division is consistent over time for each country. See also O'Mahony and Timmer (2009).

[11] For more details on the construction of the Relative TFP index, see Bournakis and Vecchi (2010).

1995-2000. Non-energy expenses for intermediate inputs, $NE_{c,i,t}$ are taken from EU KLEMS database (Crinò, 2008), and exclude fuels and mining products.

In our empirical analysis, we distinctly use a measure disentangling imports of materials from private services (respectively denoted by *M* and *S*), so that the expression (13) can be re-worded as follows:

$$MOS_{c,i,t} = IMI_{c,i,t}/NE_{c,i,t} = \sum_{j=1}^{K}(IMI_{c,i,t}^{j})/NE_{c,i,t} \qquad (16a)$$

$$SOS_{c,i,t} = ISI_{c,i,t}/NE_{c,i,t} = \sum_{j=1}^{K}(ISI_{c,i,t}^{j})/NE_{c,i,t} \qquad (16b)$$

The main shortcoming of the *broad indicators* illustrated above is that they include all sector purchases of intermediates. A finer indicator can be obtained by considering only within-industry transactions, i.e. intermediate imports of domestic (manufacturing or service) industry *j* from foreign (manufacturing or service) industry *i*. As the most relevant efficiency gains of off-shoring derive from production tasks outsourced abroad to businesses within the same industry of the relocating firm, we also use a narrow index collecting purchases of intermediate inputs from the same foreign industry. We therefore construct a *narrow indicator* defined as follows.

$$NOS_{c,i,t} = III_{c,i,t}^{j}/NE_{c,i,t} \qquad i = j\ (= M, S) \qquad (16c)$$

As a consequence, in the specification based on both broad material/services measures of off-shoring (MOS/SOS) and the narrow one (NOS), the former are net of the latter value, and thus have to be regarded as differential *off-shoring indicators* ($i \neq j$). The importance of including either measure is to separate the effect on specialisation of international outsourcing from structural change (de-industrialisation); the latter leads the share of services on GDP to rise over time.

Data on total imports distinguished by goods' type come from Bilateral Trade Database (various releases); for trade by services' categories we refer to OECD EBOPS database which, whenever necessary, has been integrated with UNCTAD series. All variables are expressed in current prices; national currencies have been converted into US dollars exploiting OECD bilateral exchange rates.

4.2 Trends in specialisation and productivity

Existing work based on US industry structure emphasises the importance of off-shoring in boosting productivity and the growth of the high-tech/high-skill sectors in the home country. According to this view, and referring to the theory of comparative advantage, high-income countries will specialise in the production of highly skilled product and services, while low income countries will specialise in the production of low-skilled labour intensive goods and services (Jensen and Kletzer 2008). We can assess this conclusion for our sample of countries by looking at changes in the industry shares of total value added (GDP), changes in the index of revealed comparative advantage (RCA) and at productivity trends. Table 1 summarizes trends in specialization patterns by country and industry. Industry shares of value added in 1990 are reported on the left-hand side of this table, while the average annual rate of change observed over the period (1990-2005) on the right-hand one. We also split the sample of industries in high tech and low tech, following the Eurostat aggregation, to highlight changes in the specialization according to the countries' comparative advantage in high tech products and services.

Due to the significant structural change experienced by most countries in the 1980s (Brakman et al. 2010), a large fraction of the market economies was represented by service industries in the early 1990s. At the beginning of our sample period the largest sector was wholesale and retail trade, followed by business services. However, while the shares of wholesale and retail trade decreased in most countries over the 1990-2005 period, business services underwent a rapid expansion. In manufacturing, electrical equipment was the most prominent sector in the early 1990s, playing a crucial role in Japan, Germany and US. A relatively high degree of specialization in food, beverage and tobacco can be observed in Denmark, Netherlands and UK, while wood was particularly important in Finland and the textile sector was pivotal in Italy. Among high-tech productions, transport equipment ranged from a 3.5% of GDP in Germany to 0.8% in Denmark, electrical equipment from 4.8 of Japan to 1.6% of Denmark. Among low-tech sectors, the width of textile in Italy was larger by a factor of four compared to the Netherlands. All low-tech manufacturing sectors experienced a decline in their value added shares over the period under investigation, particularly the textile and leather industry. Although declining trends can also be observed in several high tech manufacturing industries, the decline has not been as fast as for the low-tech sectors and in some cases, such as chemicals and electrical and optical equipment in Denmark and in Finland, industries shares have increased over time. As a result of deindustrialization, the share of service sector expanded rapidly in all the OECD area, particularly in the high-tech service industries.

Table 2 presents average values of RVA over the 1990-2005 period. By construction this index is only available for manufacturing. The figures reported in table 2 suggest that in each industry there is at least one country with a comparative advantage. A stylised fact that the above table confirms is Germany's and Japan's comparative advantage in the transport industry. Similarly, Denmark and Netherlands possess comparative advantage in food and tobacco industry. The UK economy performs relatively well in chemical industry while Germany, apart from transport, has also a comparative advantage in rubbers and plastics. USA and Japan are the leaders in electrical and optical equipment industries. As expected Italy performs well in textiles but also maintains good export performance in machinery and other non-metallic products. Finally, another stylised fact that is confirmed from the above table is the outstanding performance of Finland in wood and paper industries.To analyse cross-country and cross-industries differences in relative TFP, we construct a measure of TFP gap as follows:

$$TFPgap_{c,i,t} = RTFP_{f,i,t} - RTFP_{c,i,t} \tag{16}$$

where $RTFP_{f,c,t}$ is relative TFP in the frontier country, i.e. the one with the highest TFP level relative to the average in sector *i* at time *t*. To facilitate the interpretation, table 3 reports the negative of the TFP gap in each industry and country, in 1990 and in 2005. The figures corresponds to each industry/country TFP relative to the frontier and larger values mean that the country/industry is getting closer to the frontier. Consistently with Harrigan (1999), the United States are the frontier country in most industries; in the last year considered, they turn out to be the leader in 12 out of 17 industries, with a prevailing position in the high tech manufacturing industries. Countries are catching up with the US productivity performance in the Chemical industries, while they experience a deterioration of their productivity performance in the other high tech manufacturing industries. Among service industries, the US lost ground in post and telecommunication in 2005 to the Netherlands, and in business activities to Germany. In general, the productivity performance in these two high tech service sectors improves in most countries. In low tech manufacturing, countries' performance deteriorates over time compared to the US in several instances, with the exception of Finland, which becomes the frontier country in the wood and cork industry in 2005 as well as experiencing productivity improvements in Food, textiles, pulp paper and printing. Germany and Denmark also get closer to the frontier in the Wood industry. The catching-up process appear more widespread among service industries, with several countries/industries improving their productivity performance.

The last four columns of Table 3 report the un-weighted mean and median gap. Non-frontier countries became more similar over time, as shown by the increased closeness between these two indicators of technology gap. Second, the mean gap increased in high-tech manufacturing industries, particularly in electrical equipment, machinery and transportation equipment. As a result, TFP differentials appear to be still relevant across countries, perhaps due to intrinsic technological abilities, as well as different capacities to benefit from such productivity drivers as intangible (R&D) assets and off-shoring.

These trends suggest that both in Europe and in the US we observe an increasing specialisation towards high-tech industries, particularly high tech services. However, European countries are still lagging behind the US in terms of productivity performance, predominantly in manufacturing.

4.3 Industry and national factor endowments

Table 4 shows both the nation-wide factor endowments. The left-hand side reports the average values at the beginning of the period, while the left-hand one the average annual rate of change over the period 1990-2005. Capital series are expressed per worker units, the number of people with secondary and tertiary education as a percentage of population, whilst intensity measures of off-shoring as percentage ratio of total non-energy input expenditure. At an economy-wide level, the US showed the highest level of ICT capital per worker in the early 1990s (3.6 billions of 1995 dollars), followed by Italy and Germany. On the other tail of the distribution, Denmark and Finland start with low levels of ICT per worker in 1990 but they catch up in the next 15 years, as shown by the high rates of change. Denmark in particular experiences the fastest growth of ICT (16%) over the period, followed by the UK. Larger cross-country differences characterize non-ICT capital assets. Non-ICT capital per worker ranges from 163.8 billions of US $ in Denmark to nearly half of that amount in the UK (88 billions). This is likely to mirror the different patterns of specialization across countries.

Looking at the R&D capital per worker, the US is again in the top position in the 1990s, followed by Germany and Japan. Similarly to investment in ICT, Finland and Denmark increase their R&D effort in the 1990-2005 period experiencing the highest rates of growth (8.6% and 9.5% respectively). The US were also characterized by the largest share of medium- and highly-educated population (89%) in 1990. Italy lied on the other tail of the distribution (40.5); however, due to the reforms to the university system of the late Nineties, this country was able to partly fill the gap with the other OECD partners.

The last three rows of table 4 report descriptive statistics for the off-shoring variables at the country level. At the beginning of our sample period we observe large variations in off-shoring across countries, with larger proportion in the Netherland (32.8%) and very low proportion in Japan (5.9%). Material off-shoring was the dominant form of off-shoring in the early 1990s in all countries. In fact, the development of service off-shoring is a more recent phenomenon. However, the right hand side of table 4 shows that with the exception of the US service off-shoring is increasing rapidly, particularly in Denmark and in Germany, while material off-shoring is characterized by a declining trend in most countries. When we distinguish between international fragmentation of production tasks within and between industries (narrow- vs net imported material and service intermediate inputs), we observe that the lead of Dutch industries was particularly pronounced for narrow and the net off-shoring of service intermediates.

Table 5 reports the industry (un-weighted) levels of the determinants of TFP (equation 11). As expected, R&D capital per worker is particularly high in the high-tech industries, especially in Chemicals, electrical equipment and transportation equipment. Among high-tech services Post and Telecommunications have the higher R&D capital per worker. In Business services, R&D capital is not particularly high in 1990 but it experiences one of the largest rate of growth over the period. In the low-tech sectors we also find some reasonably high levels of R&D in Rubber and Plastic, Non Metallic Minerals and Basic Metals and Fabricated Metal Products. Part of these industries, such as the glass and ceramic industries, rely heavily on R&D and innovation in order to be able to compete in the international markets. Rates of growth of R&D are also high in several industries, including traditional ones like Textiles and Leather. Particularly large is the increase in R&D per worker in the Financial intermediation sector, averaging at 21.3% over the 1990-2005 period.

Off shoring trends show large variations across sectors. Our expectation is of larger off-shoring in the low tech industries as these rely more on low skill intensive tasks which are more easily transferred in developing countries. In fact, we find that in 1990 the largest levels of off-shoring were among low-tech industries, such as Rubber and plastic (material off-shoring), Transport and storage (service off-shoring) and textile and leather (narrow off-shoring). However, material off-shoring was also particularly high in the Electrical and optical equipment industry, which is high-tech and high skill intensive. This sector is a bit of an outlier among the high-tech industry because it does not only require highly skilled tasks (semiconductors) but also labour intensive activities (like assembly) which can be easily transferred in low-wage countries (Jensen 2008). Accordingly, narrow off-shoring, which better capture the fragmentation of production, is particularly high in this sector. In the early 1990s, textile was the sector which most intensively hinged on narrow off-shoring (24%). Service off-shoring is particularly relevant in Transport and Storage (22.8%), followed by Post and Telecommunications (5.8%). Service off-shoring is increasing in several industries, even in those that by nature do not produce tradable services, such as Financial Intermediation. In this case, service off-shoring is mainly related to computer programming or other back office tasks (Jensen 2008). Consistent with the main trends described in the existing literature, our data shows that the growth of narrow off-shoring has been highly pervasive; similarly, international fragmentation of service activities has involved all the sectors of the market economy, with the only exception of basic metals.

5. Econometric results

5.1 The endowment channel

We begin our analysis with the estimation of Equation (7) where sectoral shares of GDP are determined by relative industry TFP and national factor endowments; the latter include material and service off-shoring at the national level and endowments of R&D capital, along with the traditional endowment of labour and capital. In this section we present and discuss results based on Ordinary Least Squares, under the assumption of IID errors[12]. In section 6 we will relax this assumption and allow for the possible correlation between industry RTFP and the error term, using instrumental variables[13].

When working with a three-dimensional panel a choice must be made as to the dimension where the analysis should focus. Follwing Harrigan (1997), we carry on our analysis exploiting cross-country changes in the industry structure to identify the determinants of specialisation. Cross-countries differences in technologies and specialisation are assumed to be adequately captured by the use of country and year dummies.

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[12] The same model was estimated as a system of seemingly unrelated regressions (SURE) and the coefficient estimates were not qualitatively different. OLS estimated are based on standard errors robust to heteoskedasticity and residual autocorrelation.

[13] At an economy-wide level, factors endowment can be treated as exogenous with respect to variation in industry specialisation.

Results are shown in Table 6[14]. In 10 out of 17 industries, own relative productivity (RTFP) is a positive and significant determinant of specialisation, consistently with the theory. This impact is particularly high for electrical equipment, wholesale and retail trade, and financial intermediation where a 10% increase in relative TFP generates an increase in VA shares of respectively 0.14, 0.26 and 0.17%. Our results are largely consistent with Harrigan (1997) despite differences in model specification and data set. Average RTFP (AVG_RTFP) is expected to have a negative sign as productivity improvements in industry *i* increase its comparative advantage and its relative value added shares, but decreases specialisation in other industries. Our estimates show that the coefficient on AVG_RTFP is negative in 7 industries, while in the remaining 10 sectors is positive and often significant. This suggests the existence of complementarity effects, which are particularly strong in electrical equipment, pulp and paper products and financial intermediation.

National endowment of knowledge (R&D) capital is another important factor in explaining cross-industry differentials in specialisation. This factor favors most manufacturing industries and some tertiary sectors such as post and telecommunications and wholesale and retail trade (0.018% and 0.014% respectively). This result confirms previous work by Bournakis and Vecchi (2010) which emphasised the importance of including endowment of both tangible and intangible assets in the analysis of specialisation patterns.

The impact of international fragmentation of production is shown in table 6 via the coefficient estimates for MOS (material off-shoring) and SOS (service off-shoring). As discussed in section 3, and following the interpretation in Baldwin and Robert-Nicoud (2010), these variables proxy for ‘shadow migration’ and their coefficient estimates provides an evaluation of how much off-shoring is affecting industry shares in the home country. In several cases, material off-shoring has contributed to the expansion of several manufacturing industries, such as chemicals and electrical equipment. In services the only positive effect is in transport and storage, while there is either a negative or a non significant effect in the other industries. As a whole, the manufacturing sector gained from relocating material tasks abroad, but not from service off-shoring, which has a predominantly negative effect. In the tertiary sector, material off-shoring significantly decreases value added shares in post and telecommunications, wholesale and retail and financial services. As the coefficients of the off-shoring variables are not semi-elasticities, findings in Table 6 indicate that new forms of

[14] Note that, given the specification of Equation (7), all coefficient estimates are semi-elasticities with the exception of material and service off-shoring.

internationalisation are as important as national endowments of internal inputs for specialisation patterns (capital, human capital, etc.).

Looking at the effect of national endowments, our results show a high degree of heterogeneity in the role of ICT and non-ICT assets. The former significantly contribute to the expansion of wood, and transport and storage industries, where a 10% increase in the total economy stock of ICT capital raised the share of GDP between 0.03 and 0.05%. A negative and significant impact of ICT is found in the rubber and plastics and non-metallic minerals industry and, within services, in post and telecommunications. The impact of more traditional assets is largely differentiated between secondary and tertiary sectors, with a strong negative effect in the former group of industries.[15] This result is clearly picking up the declining trend of the manufacturing sector and the increasing shares of services. Similarly, endowments of skilled and unskilled labour reduces the value added shares in all manufacturing sectors, while increasing the shares of the service sectors. The only manufacturing industries to be positively affected by an increasing endowment of skilled and, to a lesser extent, unskilled labour are non-metallic minerals and manufacturing NEC. Interestingly, the effect of skilled labour on specialisation is considerably larger than unskilled labour in most industries. For instance, in wholesale and retails a 1% increase in the number of people with secondary and tertiary education increases the relative size of the industry by 0.09%, while a similar change in the endowment of unskilled labour generates a 0.01% increase. This is an expected outcome, given the positive relationship between skills and productivity (Nunn and Trefler, 2010, Mason et al. 2010). This result is also consistent with the evidence of increasing specialisation in high-tech service industries as these are less affected by the competitive pressure from service off-shoring. See, for example, the large and significant coefficient on skilled labour in business services.

5.2 The productivity channel

We now look at a second possible way for off-shoring and intangibles to affect specialisation i.e. via their impact on productivity. This part of the analysis is based on the estimation of equation (11) where we substitute own productivity term with the determinants of productivity at the industry level. In doing so our analysis recognises that relative productivity at the industry level is not exogenous but it is determined by industries choices

[15] For example, endowments of non-ICT capital have a positive and significant impact in post and telecommunications, wholesale and retail and financial Intermediation. In manufacturing the impact is always negative, with the only exception of the food industry.

regarding R&D investments and off-shoring. In this section we are also able to refine the treatment of off-shoring differentiating between broad off-shoring of material and services (MOSind and SOSins) and intra-industry (narrow) off-shoring, (denoted by NOSind). OLS results are presented in table 7. Starting from narrow off-shoring our findings show that this has a predominant negative effect on value added shares. The largest and significant coefficients are in three high-tech sectors, namely electrical equipment, post and telecommunications and business services, where increases in intra-industry off-shoring generates a decrease in GDP between 0.04% and 0.08%. According to the theoretical models reviewed in section 2, we should observe a positive impact of off-shoring in the high-tech industries as factors in the home countries are shifted towards more productive tasks. This does not seem to be the case for most of the high tech sectors included in our analysis, where narrow off-shoring has either a negative or insignificant effect. Only in two industries (basic metal and transport and storage) does international fragmentation of production tasks represent a source of comparative advantage. The other off-shoring variables, material and service off-shoring are generally characterised by negative coefficients in most industries. Electrical equipment and business services are the sectors where off-shoring is having the largest negative impact, while basic metals is the industry that has mainly benefited from off-shoring, in any of its form. A possible explanation at hand for the widespread negative effect of off-shoring is that this practice is likely to impose production and organization restructuring at firm level and in inter-indystry (input-output) transactions which takes a relatively long time to show up in industry figures.

R&D investments carried out by each industry have a more homogenous outcome, and consistently with our observations, they positively contribute to increasing the shares of high-tech industries and some low-tech ones, like basic metals and wholesale and retail. The impact of factor endowments (ICT and non-ICT capital, skilled and unskilled labour) on specialization presented in table 7 is generally consistent with the results presented in table 6 with the exception of ICT capital. Indeed, ICT endowment is now beneficial to the expansion of three out of 5 service industries (business services, wholesale and retail and financial intermediation). This is consistent with existing evidence testifying the growth in services, following the ICT revolution (Inklaar et al. 2008). Average RTFP also positively affect the value added shares in several industries, both in high-tech (transportation equipment and machinery) and in low-tech sectors (pulp and paper, wholesale and retail and financial intermediation).

5.3 Using the index of Revealed Comparative Advantage as an indicator of specialisation

We now adopt the Balassa index of Revealed Comparative Advantage to replicate two-channel estimations discussed above and verify whether there is consistency between specialisation and international competition indicators (see tables 8 and 9).

The first message from these estimates is that in most industries both types of off-shoring have a positive effect on comparative advantage. This may indeed be an effect of the spurious relationship between dependent and explanatory variable, as both reflect the degree of trade openness; indirectly, we tackle this issue below by adopting an instrumental variable approach of regression. If confirmed, this finding would suggest that industry specialisation is reinforced by factor "shadow migration" only for the most competitive (trade open) industries. Another remark is that the size of the off-shoring effect is largely heterogeneous across industries. On average, material off-shoring has a stronger impact than services off-shoring. This pattern is expected in low technology industries such as food and tobacco and textiles, where the parameter size of materials off-shoring is three times greater than that of services off-shoring. A similar pattern can be found in rubber and non-metallic industries. However, in high technology sectors, there is a negative effect of materials off-shoring on comparative advantage while the coefficient of services off-shoring is positive and statistically significant. A plausible explanation for this pattern is that material off-shoring is a more established practice and might be subject to decreasing returns, i.e. productivity gains have been already exhausted in high technology industries. Another explanation is that the competitive edge of high-tech industries does not lie in the compositional effects induced by outsourcing of materials.[16] Rather, if we look at the specification for productivity channel (table 9), it is generated from own R&D-based knowledge generating activities. Narrow off-shoring has a strong and negative impact on the comparative advantage of electrical equipment, similarly to the value added shares specification.

[16] As Table 8 shows, exogenous outward shifts of the technology frontier (RTFP) are instead significant for such low-tech sectors as rubber, non-metallic minerals and miscellaneous manufacturing.

6. Instrumental variable estimation

In the previous section we have assumed independence between the explanatory variables and the error term, i.e. all variables were treated as exogenous[17]. While this assumption might not be too strong for national factor endowments, industry level variables are likely to be not only affected by measurement problems but also by reverse causality. In this section we address this issue by comparing our estimates based on OLS with an instrumental variable estimator. We start with a two-step efficient Generalised Method of Moments (GMM) estimator (Hansen, 1982) where either lagged values of the explanatory variables or a set of external (institutional) variables are used as instruments (Hayashi, 2000; Baum et al., 2003). For sake of simplicity, we limit this step of analysis to industry shares of GDP as a measure of specialisation.

Internal instruments are sometimes criticized as being a mechanical strategy to tackle reverse causality. Indeed, endogeneity may not be completely expunged by lagged values of regressors, especially where a feedback may be expected from the dependent variables on regressors. The relative expansion of one industry may indeed lead firms to engage in off-shoring practices or plan complex research activities, which take a long time to be activated and finalized.[18] A more adequate strategy of identification consists in using some institutional characteristics (legal origins, political setting, market regulation, etc.), that can be safely regarded as exogenous in the elapse of time of our work. Detecting a comparable set of institutional variables is not an easy task; when available, industry-level indicators do not show up significant variation within countries, and are very persistent over time. However, a crucial advantage of our empirical framework is that its exploit cross-country variation for parameter identification, allowing us to use country-level institutional indicators. We therefore re-estimate the two specifications by respectively instrumenting own relative TFP (e.q 7) and its determinants (R&D and off-shoring; e.q 11) with different group of institutional variables: economic competitiveness (regulation of credit, labor and business, intellectual property protection, public regulation impact, bank credit, legal structure, enforcing contract cost and time); infrastructure (electrical consumption, road quality, public

[17] Harrigan (1997) shows that the degree of inconsistency due to measurement error in factor endowments is fairly small.

[18] Internal instruments should also be used with caution as, when they proliferate, they may overfit endogenous variables and weaken robustness of under- and over-identification tests (Roodman, 2009).

expenditure on education); political and social factors (corruption perception, degree of satisfaction).[19]

For ease of exposition, table 10 presents an extract of our estimates across the three estimation methods for (business services, electrical equipment and financial intermediation), showing only coefficients which might covariate (off-shoring, R&D and ICT). The full set of results is presented in appendix tables A1-A4.[20]

With few exceptions, the IV results generally confirm the OLS results presented in section 5. In the top half of table 10 (endowment channel) the identification of the impact of endowments in ICT, R&D and skills in business services appear quite problematic. R&D and ICT are positive and significant in the regression based on internal instruments while only skilled labour positively affects specialisation when using OLS and external IV estimator. This is likely to be the consequence of a complementary relationship between R&D, ICT and skills which makes identification particularly difficult; alternatively, double counting of ICT capital used to perform R&D may be particularly pronounced. The identification improves when using the second model, presented in the second half of table 10, where R&D is included as an industry variable rather than as an endowment. Similarly, in the electrical equipment industry, treating R&D as an industry variable produces more consistent results across the three estimators. Both industries are positively affected by material off-shoring, while in financial intermediation material off-shoring has a negative and significant impact, while industry off-shoring mainly leads to a reduction in their value added shares, although this result is weaker when using instrumental variables. For financial intermediation the negative impact of material off-shoring is consistent in both models and across the three estimation techniques. Similarly to the other two sectors in table 10, the impact of ICT endowment is highly significant when off-shoring and R&D are included as an industry variable.

In the remaining industries, the IV estimates re-affirm the importance of industry-level R&D in several high-tech industries as well as in some low-tech sectors, such as food and basic metals. Consistently with the OLS results, we find some strong complementarity

[19] Earlier evidence showing how institutional setting may raise either directly or indirectly TFP includes Andersen and Dalgaard (2011), Maskus et al. (2011), Ang (2011), Lynde and Richmond (1993), Salinas-Jimenez and Salinas-Jimenez (2007).

[20] At the right-hand side of each appendix table we also report the Kleibergen and Paap (2006) test of under-identification and the Hansen-J (1982) test of instrument validity. While for the endowment model the tests confirm the validity of the instruments in most instances, in the productivity model the external instruments are very often invalid, hence the interpretation of this particular set of results has to be particularly cautious.

effects in several sectors, deriving from increases in productivity in the rest of the economy. Looking at the off-shoring variables, narrow off-shoring positively affect shares in the chemical and machinery industry, while the remaining results are unchanged. As for ICT capital, its effect generally becomes stronger in the IV estimation and it is now positive not only in services but also in some manufacturing industries such as in textiles. IV results for the RCA specification are also consistent with the OLS results.

7. Concluding remarks

This work aimed at assessing the impact of off-shoring and innovative capital on specialisation, controlling for the role of traditional factor endowments and relative productivity. Following recent developments in trade theory, we constructed two testable regression frameworks. Firstly, we included off-shoring and other innovative factors into the mainstream setup. Our results show an asymmetric impact of material and service off-shoring, where the former is generally associated with a rise in industry shares of GDP while the latter is found to lower value added shares in the majority of industries. Secondly, we use a reduced form equation where we substitute relative productivity with industry level off-shoring and R&D. This model confirms the negative impact of off-shoring in key high-tech industries, particularly when we use an off-shoring measure that captures the fragmentation of production (narrow off-shoring). This seems to contradict our expectations, based on new theoretical contributions, of a reallocation of activities towards more competitive high tech sectors, following the off-shoring of less efficient tasks.

Our work has also shown the importance of accounting for innovative capital inputs, either in a tangible (ICT) or in an intangible (R&D) form. National endowment of ICT capital not only favours the most technological intensive service sectors, but also traditional sectors like textile and basic metals. R&D capital, either at the national or industry level, has a strong positive effect on specialisation. Hence the negative impact of off-shoring on specialisation appears to be compensated by industries' innovative effort. Future empirical research should investigate whether off-shoring, by releasing resources to be employed in research, is in turn a cause of increasing innovation.

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Table 1: Industry share on GDP (1990-2005)

		VALUE ADDED SHARES ON GDP (1990)								RATE OF CHANGE 1990-2005							
		DNK	FIN	GER	ITA	JPN	NLD	UK	US	DNK	FIN	GER	ITA	JPN	NLD	UK	US
High-tech industries																	
24	CHEMICALS	1.4	1.4	2.8	1.8	2.1	2.8	2.2	2.0	2.0	0.1	-1.1	-2.0	-1.4	-1.6	-2.5	-0.3
29	MACHINERY, NEC	2.6	2.9	4.3	2.6	2.8	1.5	2.0	1.6	-1.8	-0.4	-1.5	-0.3	-2.4	-1.0	-3.9	-1.1
30t33	ELECTRICAL EQ.	1.6	2.2	4.4	2.4	4.8	1.8	2.6	3.2	0.2	6.2	-1.9	-1.6	-1.9	-5.3	-4.4	-1.5
34t35	TRANSPORT EQ.	0.8	1.1	3.5	1.6	2.7	0.8	2.6	2.1	-5.9	-2.6	0.3	-3.7	0.0	-0.8	-3.6	-1.6
64	POST,COMMUNICATIONS	2.2	2.2	2.4	1.8	1.6	1.9	2.9	2.1	0.0	2.4	-1.2	1.6	1.7	2.3	-0.1	0.8
71t74	BUSINESS SERVICES	6.6	4.6	9.1	6.7	5.3	8.8	8.3	9.2	1.7	3.3	2.2	3.4	2.5	2.4	3.6	1.5
Low-tech industries																	
15t16	FOOD, BEVERAGES	3.2	2.4	2.4	2.3	3.1	3.2	3.1	2.1	-2.3	-2.4	-1.9	-1.5	-0.7	-1.6	-3.1	-1.6
17t19	TEXTILE , LEATHER	0.8	0.9	1.1	3.5	1.2	0.7	1.4	0.9	-7.4	-5.7	-6.8	-3.8	-9.5	-6.9	-9.0	-6.4
20	WOOD AND CORK	0.4	1.4	0.4	0.6	0.4	0.2	0.4	0.5	-0.1	-2.4	-1.6	-2.2	-4.9	0.3	-2.2	-1.9
21t22	PULP, PAPER , PRINTING	2.0	4.8	2.0	1.4	2.0	2.4	2.6	2.3	-2.8	-1.3	-1.6	-1.7	-1.5	-2.6	-2.5	-1.8
25	RUBBER AND PLASTICS	0.9	0.7	1.2	0.9	1.1	0.7	1.0	0.8	-0.9	0.5	-1.0	-0.9	-1.2	-3.2	-2.3	-0.5
26	OTHER NON-METALLIC MINERALS	0.8	1.1	1.1	1.5	1.0	0.7	0.9	0.5	-2.2	-1.9	-3.1	-2.1	-2.8	-3.3	-4.1	-0.2
27t28	BASIC METALS, FABRICATED METAL PRODUCTS	1.8	2.4	3.8	3.3	3.8	2.2	2.7	1.9	-1.2	1.3	-1.5	-0.4	-1.9	-1.9	-4.7	-1.1
36t37	MANUFACTURING NEC	1.1	0.8	0.8	1.1	1.0	1.2	0.6	0.7	-2.4	-2.7	-2.5	-1.5	-4.8	-1.2	-0.5	-0.7
50t52	WHOLESALE, RETAIL TRADE	12.7	11.0	10.1	14.0	12.7	13.2	11.4	10.8	-0.4	-0.2	0.2	-1.1	0.5	-0.2	0.4	0.1
60t63	TRANSPORT AND STORAGE	5.4	7.0	3.5	4.8	4.7	5.0	5.3	3.2	1.5	0.3	0.4	0.7	-0.4	-0.7	-1.0	-1.3
65t67	FINANCIAL INTERMEDIATION	4.7	4.2	4.7	5.0	5.9	4.9	5.4	5.7	0.9	-4.2	0.4	-0.3	0.8	2.9	2.5	1.3

Table 2: Average Values of Revealed Comparative Advantage (1990-2005)

		BALASSA INDEX (1990)								RATE OF CHANGE 1990-2005							
		DNK	FIN	GER	ITA	JPN	NLD	UK	US	DNK	FIN	GER	ITA	JPN	NLD	UK	US
High-tech industries																	
24	CHEMICALS	0.9	0.5	1.1	0.7	0.7	1.4	1.3	1.1	1.9	-0.7	-1.1	1.4	0.6	-0.7	-0.3	-0.4
29	MACHINERY, NEC	1.2	1.0	1.4	1.7	1.2	0.6	0.9	1.0	-0.3	0.2	-0.2	1.1	1.5	-0.3	-1.2	0.5
30t33	ELECTRICAL EQ.	0.7	1.0	0.8	0.5	1.7	1.1	1.1	1.3	1.9	5.1	0.4	-1.6	-2.0	3.1	0.1	-0.4
34t35	TRANSPORT EQ.	0.3	0.4	1.2	0.6	1.4	0.4	0.9	1.0	-1.4	-1.6	0.6	0.0	-0.1	-1.7	0.4	-0.7
64	POST,COMMUNICATIONS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71t74	BUSINESS SERVICES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low-tech industries																	
15t16	FOOD, BEVERAGES	3.7	0.3	0.7	0.8	0.1	2.6	1.0	0.9	-0.6	0.2	1.3	2.7	0.3	-1.2	-0.1	-1.5
17t19	TEXTILE , LEATHER	1.2	0.4	0.8	3.0	0.3	0.8	0.8	0.5	3.3	-4.2	-1.7	0.1	-1.8	-0.7	-0.8	1.8
20	WOOD AND CORK	1.5	5.6	0.5	0.5	0.0	0.4	0.2	0.8	-1.4	-2.2	3.0	-0.1	-4.7	-3.5	1.7	-4.4
21t22	PULP, PAPER , PRINTING	0.7	6.7	0.9	0.6	0.2	1.0	1.0	1.0	-1.1	-2.1	1.9	2.7	0.1	-0.1	1.4	0.1
25	RUBBER AND PLASTICS	1.3	0.7	1.2	1.3	0.8	1.0	0.9	0.9	-1.5	0.0	-0.3	0.3	1.4	-2.8	-1.3	1.1
26	OTHER NON-METALLIC MINERALS	1.0	0.8	1.0	2.4	0.8	0.6	0.8	0.6	1.1	2.2	-0.5	-0.4	1.8	-3.0	-0.8	1.1
27t28	BASIC METALS, FABRICATED METAL PRODUCTS	0.7	1.3	1.1	1.1	0.8	0.8	0.9	0.7	0.3	1.8	-0.3	1.6	1.4	-1.5	-0.8	0.7
36t37	MANUFACTURING NEC	2.0	0.4	0.5	2.5	0.6	0.6	0.9	0.9	-0.7	-3.0	-1.4	-1.2	-1.6	-1.7	0.8	4.1
50-52	WHOLESALE, RETAIL TRADE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60t63	TRANSPORT AND STORAGE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65t67	FINANCIAL INTERMEDIATION	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3: Analysis of the productivity frontier

		DNK		FIN		GER		ITA		JPN		NDL		UK		US		Mean gap	Median gap	Mean gap	Median gap
High-tech industries		**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**
24	CHEMICALS	42	65	56	70	53	84	43	37	65	61	55	85	49	69	100	100	58	54	65	67
29	MACHINERY, NEC	66	40	100	72	98	79	55	31	68	69	64	61	70	64	96	100	77	69	62	58
30t33	ELECTRICAL EQ.	71	16	100	85	99	26	75	10	61	32	52	13	82	23	95	100	79	79	71	72
34t35	TRANSPORT EQ.	42	12	50	42	82	70	44	20	51	51	35	47	55	49	100	100	57	51	38	25
64	POST,COMMUNICATIONS	55	59	70	90	87	99	69	70	63	67	82	100	67	86	100	74	74	69	82	85
71t74	BUSINESS SERVICES	57	56	59	36	86	100	39	43	41	74	45	56	51	63	100	86	60	54	69	66
Low-tech industries																					
15t16	FOOD, BEVERAGES	72	38	63	80	75	47	65	31	86	59	64	59	87	59	100	100	76	73	63	55
17t19	TEXTILE , LEATHER	84	55	60	68	97	79	80	34	73	62	99	73	100	68	93	100	86	88	72	70
20	WOOD AND CORK	47	64	58	100	57	94	47	46	45	45	25	28	52	43	100	87	54	49	63	57
21t22	PULP, PAPER , PRINTING	61	47	83	95	74	60	61	37	65	45	63	57	88	59	100	100	74	69	70	71
25	RUBBER AND PLASTICS	100	56	98	68	98	87	63	37	63	53	78	57	63	47	88	100	81	83	81	80
26	OTHER NON-METALLIC MINERALS	81	61	82	81	89	82	66	42	73	61	78	53	84	83	100	100	82	81	59	59
27t28	BASIC METALS, FABRICATED METAL PRODUCTS	69	46	100	95	99	85	60	41	71	57	73	69	85	75	89	100	81	79	67	68
36t37	MANUFACTURING NEC	78	46	84	68	90	59	59	36	81	60	79	52	100	51	92	100	83	82	49	48
50t52	WHOLESALE, RETAIL TRADE	62	84	74	88	76	100	100	75	50	87	57	75	53	59	57	88	66	59	59	55
60t63	TRANSPORT AND STORAGE	93	70	95	86	62	67	86	60	68	55	73	68	89	74	100	100	83	87	64	60
65t67	FINANCIAL INTERMEDIATION	59	92	100	83	57	45	58	44	80	100	47	55	52	65	64	68	65	59	69	74

Table 4: Economy wide factor endowments

	LEVELS 1990								RATE OF CHANGE 1990-2005							
	DNK	FIN	GER	ITA	JPN	NLD	UK	US	DNK	FIN	GER	ITA	JPN	NLD	UK	US
ICT capital per worker (bill. USD 1995)	1.7	2.2	3.2	3.5	2.7	2.8	2.4	3.6	16.5	10.8	8.4	6.1	10.4	10.9	12.8	12
Non-ICT capital per worker (bill. USD 1995)	163	117	126	138	101	156	88	123	0.9	2.2	3.8	-0.2	5.4	0.8	1.5	1.6
R&D capital per worker (bill. USD 1995)	1.4	1.8	3.3	1.4	3.1	2.3	2.5	4.6	8.6	9.5	3.9	2.3	5.6	2.9	3	3.9
Share of population with secondary and tertiary education (%)	69.5	64.8	66.6	40.5	65.7	61.5	52.4	89.6	0.2	0.9	0.5	1.5	1	0.9	1.1	
Total off-shoring	26.6	19.1	18.0	18.4	5.9	32.8	21.7	10.8	1.9	2.3	1.1	-0.9	3.5	-1.7	-2.6	-0.8
Total material off-shoring	18.0	13.4	14.3	14.3	3.4	22.1	17.4	7.6	-0.9	2.0	-0.2	-1.5	2.5	-3.0	-3.5	0.5
Total service off-shoring	8.6	5.7	3.7	4.2	1.5	10.7	4.3	3.1	8.2	3.4	4.8	1.1	3.4	0.6	0.4	-5.4

Table 5: Summary statistics at industry level

		LEVELS 1990				RATE OF CHANGE 1990-2005			
		R&D p.w	*MOS*	*SOS*	*NOS*	*R&D p.w*	*MOS*	*SOS*	*NOS*
High-tech industries									
24	CHEMICALS	44.5	6.2	3.5	19.6	6.2	-0.1	1.8	2.1
29	MACHINERY, NEC	8	13	2.8	9.3	7.3	1.4	0.8	2.1
30t33	ELECTRICAL EQ.	34.1	19.6	3	12.5	5.7	-1.9	4.4	2.8
34t35	TRANSPORT EQ.	29.7	14.2	2.6	11.6	4	1.4	1.8	2.5
64	POST,COMMUNICATIONS	15.5	3.3	5.8	2.6	10.1	3.4	5.3	6.2
71t74	BUSINEE SERVICES	2.5	5.3	2.9	4.4	8.8	-187	5	4.2
Low-tech industries									
15t16	FOOD, BEVERAGES	2.8	8.5	1.7	6.4	6	0.3	5.1	0.2
17t19	TEXTILE , LEATHER	0.7	13	2.9	24.3	11.1	-0.3	3.4	0.3
20	WOOD AND CORK	1	11.9	2.9	13.9	10	-1.3	0.5	0.4
21t22	PULP, PAPER , PRINTING	1.1	4.9	3.2	16.6	9.5	1.8	3.8	-1.4
25	RUBBER AND PLASTIC	4.3	29.5	3	4	6	-0.3	0.6	2.7
26	OTHER NON METALLIC MIN.	3.7	10.8	4.3	6.2	4.6	1	0.7	0.2
27T28	BASIC METAL, FABBR.MET.PROD.	3.6	14.6	3.3	9.4	2.7	0.7	-0.5	1.4
36t37	MANUFACTURING NEC	3.2	18.7	6	3.5	7.4	0.8	1.1	2.2
G	WHOLESALE, RETAIL TRADE	0.2	9.3	4.6	NA	21	-3.4	4.5	NA
60t63	TRANSPORT AND STORAGE	1.5	2.6	22.8	14.1	6.4	1.7	-10.4	7.8
J	FINANCIAL INTERMEDIATION	0.2	0.7	3	1.6	21.3	-0.7	3.3	6.7

Note: R&D p.w.=R&D per worker, MOS=material off-shoring; SOS=service off-shoring; NOS=intra-industry (narrow) off-shoring. MOS and SOS are net of narrow off-shoring (NOS).

Table 6: Off-shoring, intangibles and specialisation: endowment channel, eq. 7 **(OLS)**

		RTFP	AVG RTFP	ICT	NICT	SK	UNSK	R&D	MOS	SOS	R-2
HIGH-TECH	CHEMICALS	0.56*	-0.35	0.21	-0.72*'	-2.28	0.03	-0.03	0.06*	-0.01	0.93
		(0.25)	(0.34)	(0.34)	(0.35)	(1.52)	(0.35)	(0.33)	(0.02)	(0.02)	
	MACHINERY	0.68	0.77	0.06	-2.65***'	-1.91	-0.68	-0.36	0.06	-0.03**'	0.98
		(0.43)	(0.81)	(0.38)	(0.45)	(1.21)	(0.43)	(0.39)	(0.04)	(0.01)	
	ELECTRICAL EQ.	1.37***	2.10**	-0.20	-7.28***'	-1.83	-4.34***'	1.81**'	0.14***	-0.05	0.96
		(0.33)	(0.84)	(0.31)	(1.15)	(3.51)	(0.60)	(0.60)	(0.04)	(0.03)	
	TRANSPORT EQ.	0.32	0.44	-0.01	-0.42	-5.18***'	-0.91**'	-0.68	0.04	0.02	0.99
		(0.23)	(0.62)	(0.37)	(0.45)	(1.08)	(0.37)	(0.42)	(0.05)	(0.01)	
	POST & TELS:	0.50***	0.17	-0.80***'	0.63*	5.89***	0.64**'	1.81***'	-0.03**'	-0.05***'	0.90
		(0.17)	(0.32)	(0.20)	(0.33)	(1.04)	(0.30)	(0.24)	(0.02)	(0.02)	
	BUSINESS SER.	0.23	-0.69	0.73	-0.46	14.90***	-0.13	-1.49**'	-0.05	0.04	0.98
		(0.41)	(0.89)	(0.50)	(0.79)	(2.17)	(0.77)	(0.61)	(0.06)	(0.04)	
HIGH-TECH	FOOD	0.50*	-1.48***'	-0.17	1.06***	-3.13***'	0.33	-0.60**'	0.02	-0.01	0.96
		(0.28)	(0.39)	(0.20)	(0.27)	(0.69)	(0.24)	(0.25)	(0.02)	(0.01)	
	TEXTILE	0.05	1.26***	-0.01	-0.48***'	-1.63**'	0.00	0.39***'	-0.03**'	0.01*'	0.99
		(0.08)	(0.24)	(0.09)	(0.14)	(0.63)	(0.12)	(0.10)	(0.01)	(0.01)	
	WOOD	0.10	0.28	0.27***	-0.34*'	-0.57*'	-0.34**'	-0.35**'	0.01	-0.01	0.97
		(0.09)	(0.20)	(0.09)	(0.19)	(0.32)	(0.13)	(0.13)	(0.01)	(0.00)	
	PULP, PAPER	-1.37**'	3.50***	0.30	-2.68***'	-0.17	-1.02***'	-0.70	0.12***	0.00	0.98
		(0.57)	(0.95)	(0.26)	(0.52)	(1.22)	(0.29)	(0.48)	(0.02)	(0.02)	
	RUBBER	0.59***	-0.15*'	-0.09**'	-0.79***'	-0.49**'	-0.38***'	0.33***'	0.01***	-0.01***'	0.97
		(0.08)	(0.08)	(0.04)	(0.08)	(0.21)	(0.07)	(0.05)	(0.00)	(0.00)	
	NON MET. MIN.	0.17	-0.29*'	-0.10*'	0.19	0.93***	0.54***	0.41***	-0.01	-0.01**'	0.96
		(0.12)	(0.13)	(0.05)	(0.12)	(0.28)	(0.08)	(0.07)	(0.01)	(0.01)	
	BASIC METALS	0.70**	0.65*	-0.15	-3.08***'	-3.77***'	-0.51**'	0.07	0.07***	-0.02	0.97
		(0.29)	(0.37)	(0.17)	(0.29)	(0.83)	(0.24)	(0.17)	(0.02)	(0.01)	
	MANUF. NEC	-0.24*'	0.39***	-0.05	-0.24**'	1.05**	0.40***	0.00	-0.01	0.00	0.96
		(0.12)	(0.13)	(0.06)	(0.12)	(0.44)	(0.10)	(0.09)	(0.01)	(0.01)	
	WHOLESALE	2.56**	0.48	-0.33	2.03**	9.38***	1.11**	1.17**	-0.09**'	0.05	0.96
		(1.16)	(1.05)	(0.37)	(0.95)	(2.15)	(0.54)	(0.52)	(0.04)	(0.04)	
	TRANSPORTS	0.58**	-1.41***'	0.54***	-1.93***'	-4.26***'	-0.93***'	-0.64***'	0.09***	0.06***	0.99
		(0.28)	(0.40)	(0.15)	(0.31)	(1.06)	(0.18)	(0.22)	(0.02)	(0.02)	
	FIN. INTERMED.	1.74***	1.65**	-0.24	1.52**	-0.06	1.25	-0.76	-0.19***'	-0.06	0.88
		(0.57)	(0.68)	(0.65)	(0.59)	(1.92)	(0.77)	(0.58)	(0.04)	(0.04)	

Note: OLS estimation with HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. RTFP=industry Relative TFP. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SKI= Medium- and highly-educated workers. UNSK= Low-educated workers. R&D= national endowment of R&D capital. MOS=national intensity of material (broad) off-shoring. SOS=national intensity of service (broad) off-shoring.

Table 7: Off-shoring, intangibles and specialisation: productivity channel, eq. 11 (OLS)

		NOS_i	MOS_i	SOS_i	$R\&D_i$	AVG RTFP	ICT	NICT	SK	UNSK	R-2
HIGH-TECH	CHEMICALS	0.00	0.02	-0.03	0.53***	0.19	-0.28	-1.10***	-5.53***	-0.05	0.93
		(0.01)	(0.02)	(0.02)	(0.16)	(0.25)	(0.18)	(0.19)	(0.93)	(0.17)	
	MACHINERY	0.016	0.04***	-0.07***	0.40***	0.99***	-0.17	-2.52***	-4.91***	-0.52**	0.98
		(0.02)	(0.02)	(0.02)	(0.08)	(0.29)	(0.11)	(0.35)	(1.10)	(0.21)	
	ELECTRICAL EQ.	-0.04***	-0.05***	-0.03**	1.60***	0.13	-0.63***	-3.10***	-7.67***	-0.65	0.96
		(0.01)	(0.01)	(0.01)	(0.22)	(0.77)	(0.19)	(0.53)	(1.94)	(0.40)	
	TRANSPORT EQ.	0.015	-0.00	0.04*	0.08	1.64***	-0.44***	-0.81*	-5.16***	-0.96***	0.98
		(0.01)	(0.01)	(0.02)	(0.20)	(0.38)	(0.09)	(0.44)	(1.06)	(0.20)	
	POST & TELS:	-0.08***	-0.01	0.01	0.17***	0.24	-1.06***	1.99**	-8.22***	-1.52***	0.93
		(0.03)	(0.02)	(0.01)	(0.07)	(0.34)	(0.20)	(0.95)	(1.82)	(0.31)	
	BUSINESS SER.	-0.08***	-0.03	-0.34***	0.32***	-0.62	1.52***	-1.12**	10.2***	-1.42***	0.99
		(0.03)	(0.02)	(0.06)	(0.07)	(0.7)	(0.22)	(0.54)	(2.03)	(0.42)	
HIGH-TECH	FOOD	-0.00	-0.01	0.00	0.68***	-0.28	-0.49***	1.45***	-2.05***	0.65***	0.97
		(0.02)	(0.01)	(0.05)	(0.17)	(0.30)	(0.09)	(0.21)	(0.63)	(0.16)	
	TEXTILE	-0.00	-0.01	-0.04***	0.03	0.50*	0.25***	-0.35**	-3.26***	-0.02	0.99
		(0.00)	(0.00)	(0.01)	(0.08)	(0.28)	(0.08)	(0.15)	(0.76)	(0.12)	
	WOOD	-0.01***	0.01	0.01	-0.04**	0.10	0.06	0.25	1.50***	0.28	0.97
		(0.00)	(0.01)	(0.0)	(0.02)	(0.21)	(0.04)	(0.22)	(0.55)	(0.18)	
	PULP, PAPER	-0.02*	0.04	0.09*	0.19	4.49***	-0.53***	-2.07***	0.92	-1.38***	0.97
		(0.01)	(0.04)	(0.05)	(0.16)	(1.14)	(0.20)	(0.58)	(1.45)	(0.45)	
	RUBBER	-0.02*	0.01***	-0.01	-0.07	-0.04	0.12*	-0.57***	-2.27***	-0.24***	0.95
		(0.01)	(0.00)	(0.01)	(0.06)	(0.16)	(0.07)	(0.13)	(0.62)	(0.08)	
	NON MET. MIN.	-0.02	-0.01**	-0.02**	-0.09	0.10	0.08	0.09	1.52**	0.35***	0.97
		(0.01)	(0.00)	(0.01)	(0.06)	(0.11)	(0.05)	(0.11)	(0.62)	(0.07)	
	BASIC METALS	0.05**	0.02*	0.05**	0.46***	1.49***	-0.62***	-3.34***	-4.10***	-0.22	0.96
		(0.02)	(0.01)	(0.02)	(0.14)	(0.46)	(0.19)	(0.40)	(0.79)	(0.30)	
	MANUF. NEC	-0.02	-0.01***	0.01**	-0.02	0.16	0.02	-0.33***	0.07	0.43***	0.97
		(0.02)	(0.00)	(0.00)	(0.04)	(0.17)	(0.08)	(0.12)	(0.65)	(0.07)	
	WHOLESALE		-0.02	0.11***	-0.07	2.24**	0.56**	3.38***	12.5***	1.16**	0.95
			(0.02)	(0.02)	(0.05)	(0.92)	(0.24)	(0.94)	(3.07)	(0.45)	
	TRANSPORTS	0.01***	0.04	0.00	0.02	-0.93**	-0.04	-1.45***	-4.39**	-0.30	0.99
		(0.00)	(0.03)	(0.00)	(0.07)	(0.38)	(0.14)	(0.44)	(1.80)	(0.34)	
	FIN. INTERMED.	-0.01	-1.50***	0.01	-0.01	3.18***	0.82*	-0.38	2.41	-1.62**	0.87
		(0.57)	(0.09)	(0.06)	(1.06)	(0.46)	(0.86)	(3.23)	(0.64)	(53.71)	

Note: OLS estimation with HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. NOS_i= intensity of intra-industry (narrow) off-shoring. MOS_i=industry intensity of material (broad) off-shoring. SOS_i= industry intensity of service (broad) off-shoring R&D= national endowment of R&D capital. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SK= Medium- and highly-educated workers. UNSK= Low-educated workers.

Table 8: Off-shoring, intangibles and RCA specialisation: endowment channel, eq. 7 (OLS)

		RTFP	AVG RTFP	ICT	NICT	SK	UNSK	R&D	MOS	SOS	R-2
HIGH-	CHEMICALS	-0.02	-0.50***	0.09	-0.14	-0.04	0.18	0.03	0.27*	0.02	0.98
TECH		(0.10)	(0.11)	(0.07)	(0.12)	(0.21)	(0.10)	(0.08)	(0.11)	(0.05)	
	MACHINERY	0.17	-0.47***	-0.20***	-0.09	-0.05	0.06	0.16**	0.21***	-0.11***	0.94
		(0.07)	(0.12)	(0.04)	(0.10)	(0.13)	(0.12)	(0.05)	(0.11)	(0.11)	
	ELECTRICAL EQ.	-0.02	1.21***	0.00	-1.00***	0.68**	-0.49***	0.50***	-0.28*	0.01	0.95
		(0.14)	(0.09)	(0.24)	(0.20)	(0.24)	(0.12)	(0.24)	(0.12)	(0.08)	
	TRANSPORT EQ.	-0.01	0.00	-0.10*	0.10	-0.01	0.06	-0.03	-0.19**	0.10***	0.94
		(0.03)	(0.09)	(0.04)	(0.07)	(0.11)	(0.43)	(0.21)	(0.04)	(0.03)	
LOW-	FOOD	-0.01	-0.44	-0.19*	-0.15	0.46	0.24*	-0.13	0.29**	0.06	0.92
TECH		(0.14)	(0.40)	(0.08)	(0.14)	(0.24)	(0.12)	(0.09)	(0.11)	(0.05)	
	TEXTILE	0.11	-1.03***	0.28***	-0.18	-0.40*	0.32***	0.07)	0.30***	-0.06	0.93
		(0.07)	(0.12)	(0.04)	(0.10)	(0.17)	(0.08)	(0.04)	(0.08)	(0.03)	
	WOOD	0.18	-1.46***	0.25	1.66***	-0.81	0.74***	-1.05***	-0.36	0.18	0.91
		(0.20)	(0.24)	(0.10)	(0.27)	(0.50)	(0.20)	(0.18)	(0.20)	(0.10)	
	PULP, PAPER	-0.50	-1.08*	0.23	1.46***	-1.02*	1.01***	-0.96***	-0.40*	0.04	0.98
		(0.39)	(0.43)	(0.14)	(0.28)	(0.43)	(0.21)	(0.17)	(0.20)	(0.09)	
	RUBBER	0.37***	-0.51***	-0.17**	0.08	-0.31*	0.24**	0.13	0.35***	-0.08*	0.97
		(0.11)	(0.10)	(0.05)	(0.09)	(0.15)	(0.08)	(0.07)	(0.07)	(0.03)	
	NON MET. MIN.	0.21*	-0.11	-0.02	-0.1	0.02	0.10	0.05	0.38***	0.04	0.96
		(0.10)	(0.09)	(0.05)	(0.09)	(0.14)	(0.08)	(0.04)	(0.08)	(0.03)	
	BASIC METALS	0.05	-0.40**	-0.13*	0.01	-0.17	-0.10	0.14*	0.25**	-0.03	0.96
		(0.13)	(0.14)	(0.17)	(0.08)	(0.18)	(0.09)	(0.07)	(0.08)	(0.04)	
	MANUF. NEC	0.30*	0.47**	0.21**	-0.06	0.35	0.14	-0.34***	0.07	-0.01	0.90
		(0.13)	(0.14)	(0.07)	(0.12)	(0.21)	(0.11)	(0.08)	(0.10)	(0.04)	

Note: OLS estimation with HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. . RTFP=industry Relative TFP. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SKI= Medium- and highly-educated workers. UNSK= Low-educated workers. R&D= national endowment of R&D capital. MOS=national intensity of material (broad) off-shoring. SOS=national intensity of service (broad) off-shoring.

Table 9: Off-shoring, intangibles and RCA specialisation: productivity channel, eq. 11 (OLS)

		NOS_i	MOS_i	SOS_i	$R\&D_i$	AVG RTFP	ICT	NICT	SK	UNSK	R-2
HIGH-	CHEMICALS	0.04	-0.05	0.13	0.45***	-0.42***	-0.30***	-0.13	-0.34*	0.11	0.91
TECH		(0.03)	(0.04)	(0.07)	(0.08)	(0.12)	(0.09)	(0.09)	(0.14)		
	MACHINERY	0.11***	0.00	0.02	0.07*	-0.13	-0.16***	-0.32**	0.26*	0.13	0.9
		(0.03)	(0.02)	(0.06)	(0.03)	(0.09)	(0.04)	(0.12)	(0.13)	(0.07)	
	ELECTRICAL EQ.	-0.23***	0.16***	-0.18***	-0.05	0.27	0.21***	-0.28	0.54**	-0.31*	0.98
		(0.03)	(0.03)	(0.04)	(0.04)	(0.16)	(0.05)	(0.15)	(0.19)	(0.13)	
	TRANSPORT EQ.	-0.11***	0.03*	0.00	0.19***	-0.20*	-0.11***	-0.06	-0.16	0.06	0.89
		(0.03)	(0.01)	(0.03)	(0.06)	(0.09)	(0.03)	(0.14)	(0.12)	(0.06)	
LOW-	FOOD	0.16**	0.09**	0.05	-0.30***	-0.27	-0.44***	-0.15	0.91***	0.21	0.92
TECH		(0.06)	(0.03)	(0.04)	(0.08)	(0.17)	(0.06)	(0.13)	(0.27)	(0.12)	
	TEXTILE	0.14***	0.00	0.10**	0.18***	-0.44***	0.36***	-0.20*	-0.1	-0.13	0.95
		(0.03)	(0.02)	(0.03)	(0.04)	(0.11)	(0.06)	(0.09)	(0.15)	(0.09)	
	WOOD	-0.95***	0.21***	0.08	-0.07	0.05	-0.41**	-0.97*	0.07	1.17***	0.99
		(0.17)	(0.05)	(0.11)	(0.04)	(0.41)	(0.14)	(0.45)	(0.48)	(0.27)	
	PULP, PAPER	-0.21*	0.20*	-0.33*	0.15	-1.00*	-0.34*	1.07**	-1.82**	0.91*	0.96
		(0.10)	(0.08)	(0.15)	(0.10)	(0.47)	(0.17)	(0.33)	(0.63)	(0.37)	
	RUBBER	0.25***	0.07**	0.10**	0.08	-0.01	-0.18***	-0.29*	0.41*	0.02	0.96
		(0.02)	(0.02)	(0.04)	(0.04)	(0.10)	(0.05)	(0.12)	(0.17)	(0.08)	
	NON MET. MIN.	0.08	0.00	0.12***	-0.22***	0.21*	-0.01	-0.24*	-0.56	0.06	0.99
		(0.05)	(0.03)	(0.03)	(0.04)	-0.09	(0.05)	(0.11)	(0.38)	(0.09)	
	BASIC METALS	0.14**	0.07*	0.06	0.12	-0.20	-0.17*	(0.26	0.16	0.14	0.86
		(0.05)	(0.03)	(0.06)	(0.07)	(0.14)	(0.07)	(0.14)	(0.19)	(0.10)	
	MANUF. NEC	-0.15*	0.09**	0.00	-0.18***	0.98***	-0.20*	-0.24	0.35	0.30*	0.92
		(0.06)	(0.03)	(0.07)	(0.05)	(0.18)	(0.09)	(0.14)	(0.21)	(0.13)	

Note: OLS estimation with HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. NOS_i= intensity of intra-industry (narrow) off-shoring. MOS_i=industry intensity of material (broad) off-shoring. SOS_i= industry intensity of service (broad) off-shoring R&D= national endowment of R&D capital. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SK= Medium- and highly-educated workers. UNSK= Low-educated workers.

Table 10: OLS vs IV-GMM estimation (based on internal and external instruments) for selected industries: endowment vs specialisation channel (eq. 7 vs eq. 11)

Endowment channel	Business Services			Electrical Equipment			Financial Intermediation		
	OLS	IV (int.)	IV (ext.)	OLS	IV (int.)	IV (ext.)	OLS	IV (int.)	IV (ext.)
RTFP	0.23	0.13	1.12	1.37***	1.80***	3.00***	1.74***	1.99***	2.73***
	(0.41)	(0.74)	(0.81)	(0.33)	(0.53)	(0.45)	(0.57)	(0.71)	(0.87)
ICT	0.73	1.35***	0.55	-0.20	-0.13	-0.03	-0.24	-0.76	-0.71
	(0.50)	(0.45)	(0.76)	(0.31)	(0.42)	(0.39)	(0.65)	(0.81)	(0.81)
RD	-1.49**	17.7***	-0.86	1.82**	-5.89	-0.06	-0.76	-1.01	-0.62
	(0.61)	(4.01)	(1.29)	(0.60)	(5.99)	(0.69)	(0.58)	(2.83)	(0.51)
SK	14.9***	-0.90	15.3***	-1.83	-4.97***	-11.4***	-0.06	1.413**	1.02
	(2.17)	(0.81)	(4.21)	(3.51)	(1.16)	(3.41)	(1.92)	(0.71)	(2.14)
MOS	0.06**	0.04**	0.06***	0.14***	0.12**	0.07*	-0.19***	-0.20***	-0.21***
	(0.02)	(0.02)	(0.02)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.07)
SOS	-0.01	-0.01	-0.01	-0.05	-0.06**	-0.04	-0.06	-0.05	-0.04
	(0.02)	(0.01)	(0.01)	(0.03)	(0.02)	(0.03)	(0.04)	(0.04)	(0.04)
Productivity channel									
NOS_i	-0.08***	-0.09*	-0.04	-0.04***	-0.02	-0.09	-0.01	0.01	0.08
	(0.03)	(0.05)	(0.15)	(0.01)	(0.026)	(0.08)	(0.03)	(0.05)	(0.18)
MOS_i	-0.03	-0.03	0.04	-0.05***	0.02	0.09	-1.50***	-3.69***	-1.91
	(0.02)	(0.04)	(0.04)	(0.01)	(0.032)	(0.07)	(0.57)	(0.57)	(1.39)
SOS_i	-0.34***	-0.36***	-0.70***	-0.03**	-0.05**	0.10	0.09	0.04	-0.15
	(0.06)	(0.09)	(0.17)	(0.01)	(0.02)	(0.08)	(0.09)	(0.12)	(0.25)
RDS_i	0.32***	0.33***	0.39*	1.60***	2.92***	2.90***	-0.01	0.05	-0.16
	(0.07)	(0.06)	(0.20)	(0.22)	(0.47)	(0.73)	(0.06)	(0.06)	(0.13)
ICT	1.52***	1.68***	2.66***	-0.63***	-1.03***	-1.17***	0.82*	1.46**	1.71***
	(0.22)	(0.41)	(0.45)	(0.19)	(0.31)	(0.42)	(0.46)	(0.64)	(0.53)
SK	10.2***	10.5***	5.91	-7.67***	-7.99*	-3.72	2.41	-5.31	3.79
	(2.03)	(3.58)	(8.22)	(1.94)	(4.478)	(4.21)	(3.23)	(3.90)	(5.48)

Note: OLS and IV-GMM estimations with HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. IV-GMM uses either lagged values or institutional variables to RTFP, NOS_i, MOS_i and SOS_i.

Endowment channel: RTFP=industry Relative TFP. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SKI= Medium- and highly-educated workers. UNSK= Low-educated workers. R&D= national endowment of R&D capital. MOS=national intensity of material (broad) off-shoring. SOS=national intensity of service (broad) off-shoring.

Productivity channel: NOS_i= intensity of intra-industry (narrow) off-shoring. MOS_i=industry intensity of material (broad) off-shoring. SOS_i= industry intensity of service (broad) off-shoring R&D= national endowment of R&D capital. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SK= Medium- and highly-educated workers. UNSK= Low-educated workers.

Table A1: IV-GMM estimation with internal instruments: productivity channel, eq. 7

		RTFP	AVG RTFP	ICT	NICT	SK	UNSK	R&D	MOS	SOS	R-2	K-Paap LM	Han-sen J
HIGH-	CHEMICALS	0.61***	-0.78***	-0.03	-0.23	-3.38**	0.35	0.126	0.04**	-0.01	0.93	5.35	0.00
TECH		(0.23)	(0.27)	(0.21)	(0.38)	(1.40)	(0.23)	(0.21)	(0.02)	(0.01)		[0.07]	[1.00]
	MACHINERY	1.49	-0.56	-0.18	-2.64***	-2.35	-0.52	-0.13	0.07*	-0.02	0.97	2.28	1.85
		(1.68)	(2.01)	(0.26)	(0.70)	(2.44)	(0.42)	-0.1303	(0.04)	(0.02)		[0.32]	[0.17]
	ELECTRICAL EQ.	1.80***	1.1427	-0.13	-8.45***	-5.89	-4.97***	(0.29)	0.12**	-0.06**	0.96	8.12	1.00
		(0.53)	(0.93)	(0.42)	(2.01)	(5.99)	(1.16)	(0.97)	(0.05)	(0.02)		[0.02]	[0.32]
	TRANSPORT EQ.	-0.13	0.89	-0.61***	-0.15	-10.5***	-0.69**	-0.35**	-0.05**	0.01	0.99	4.04	0.00
		(0.24)	(0.65)	(0.16)	(0.44)	(1.15)	(0.19)	(0.14)	(0.02)	(0.01)		[0.13]	[0.96]
	POST, TELECOMS	0.93***	-0.31	-0.92***	1.63***	7.99***	1.13***	1.87***	-0.02	-0.04*	0.91	7.88	3.03
		(0.24)	(0.44)	(0.14)	(0.47)	(1.72)	(0.28)	(0.23)	(0.03)	(0.02)		[0.05]	[0.22]
	BUSINESS SER.	0.13	0.2279	1.35***	-1.83	17.72***	-0.90	-2.28***	0.05	0.03	0.98	11.23	0.53
		(0.74)	(1.30)	(0.48)	(1.22)	(4.01)	(0.81)	(0.66)	(0.08)	(0.04)		[0.00]	[0.47]
LOW-	FOOD	-0.11	-1.45***	-0.48***	1.71***	-4.48***	0.93***	-0.14	-0.03**	-0.02**	0.97	7.79	0.20
TECH		(0.34)	(0.43)	(0.15)	(0.28)	(0.92)	(0.13)	(0.27)	(0.01)	(0.01)		[0.02]	[0.66]
	TEXTILE	0.22	1.22***	0.00	-0.90***	-3.08**	-0.21	0.39***	-0.03*	0.01	0.99	5.86	1.79
		(0.16)	(0.39)	(0.12)	(0.30)	(1.39)	(0.18)	(0.14)	(0.02)	(0.01)		[0.05]	[0.18]
	WOOD	0.45	-0.09	0.35**	-0.07	0.26	-0.29***	-0.41**	0.00	-0.01	0.97	5.52	0.31
		(0.50)	(0.38)	(0.16)	(0.35)	(1.17)	(0.09)	(0.20)	(0.01)	(0.01)		[0.06]	[0.58]
	PULP, PAPER	1.95*	2.01	-1.65***	-2.36**	2.52**	0.52***	0.18	- 0.14***	0.04	0.91	5.56	0.00
		(1.15)	(1.89)	(0.22)	(1.01)	(1.12)	(0.19)	(0.41)	(0.04)	(0.03)		[0.06]	[0.98]
	RUBBER	0.98***	-0.09	-0.12**	-1.16***	-0.40	-0.63***	0.43***	0.01**	-0.01***	0.96	6.20	3.69
		(0.18)	(0.14)	(0.05)	(0.14)	(0.30)	(0.12)	(0.06)	(0.01)	(0.00)		[0.05]	[0.05]
	NON-MET. MIN.	0.56	-0.38	-0.20**	0.12	1.51***	0.41***	0.50***	-0.01	-0.01	0.96	4.72	0.10
		(0.37)	(0.26)	(0.08)	(0.15)	(0.52)	(0.08)	(0.08)	(0.01)	(0.01)		[0.09]	[0.75]
	BASIC METALS	0.83*	-0.13	-0.34	-2.51***	-5.24***	-0.26	0.29	0.05**	-0.02*	0.97	7.09	1.16
		(0.44)	(0.68)	(0.24)	(0.62)	(1.24)	(0.38)	(0.22)	(0.02)	(0.01)		[0.03]	[0.28]
	MANUF. NEC	-0.71***	0.83***	-0.24**	-0.09	1.64***	0.64***	0.24*	-0.01	0.01	0.96	4.71	0.19
		(0.27)	(0.17)	(0.11)	(0.18)	(0.47)	(0.20)	(0.13)	(0.01)	(0.00)		[0.09]	[0.66]
	WHOLESALE	0.40	-1.62***	0.53***	-1.95***	-7.28***	-0.75***	-0.66**	0.05***	0.05***	0.99	8.31	0.29
		(0.36)	(0.60)	(0.19)	(0.46)	(1.46)	(0.22)	(0.27)	(0.02)	(0.01)		[0.02]	[0.59]
	TRANSPORTS	1.66	3.41*	0.08	0.11	12.56***	0.19	1.00	-0.02	0.07	0.96	7.50	0.34
		(1.98)	(1.90)	(0.48)	(1.29)	(3.02)	(0.64)	(0.67)	(0.04)	(0.05)		[0.02]	[0.56]
	FIN. INTERMED.	1.99***	1.47	-0.76	1.57	-1.01	1.41**	-0.35	- 0.20***	-0.05	0.89	5.40	0.19
		(0.71)	(1.72)	(0.81)	(1.53)	(2.83)	(0.71)	(0.52)	(0.05)	(0.04)		[0.07]	[0.66]

Note: IV-GMM estimations based on lagged values of RTFP as instruments. HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. R-2=R-squared. K-Paap LM=Kleibergen-Paap (2006) test of under-identification. Hansen J test of over-identification. P-values in brackets. RTFP=industry Relative TFP. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SKI= Medium- and highly-educated workers. UNSK= Low-educated workers. R&D= national endowment of R&D capital. MOS=national intensity of material (broad) off-shoring. SOS=national intensity of service (broad) off-shoring.

Table A2: IV-GMM estimation with internal instruments: productivity channel, eq. 11

		NOS$_i$	MOS$_i$	SOS$_i$	R&D$_i$	AVG RTFP	ICT	NICT	SK	UNSK	R-2	K-Paap LM	Han-sen J
HIGH-	CHEMICALS	0.02**	0.00	-0.04	0.64***	-0.27	-0.31	-0.88***	-7.89***	0.16	0.92	6.86	2.06
TECH		(0.01)	(0.02)	(0.03)	(0.13)	(0.40)	(0.21)	(0.29)	(1.94)	(0.19)		[0.03]	[0.15]
	MACHINERY	0.05**	0.09***	-0.06***	0.43***	1.07**	-0.03	-3.39***	-7.87***	-1.01***	0.98	7.05	1.59
		(0.02)	(0.02)	(0.02)	(0.08)	(0.491)	(0.17)	(0.64)	(1.61)	(0.33)		[0.03]	[0.21]
	ELECTRICAL EQ.	-0.02	0.02	-0.05**	2.92***	3.09*	-1.04***	-5.37***	-7.99*	-1.29	0.94	5.18	2.01
		(0.03)	(0.03)	(0.02)	(0.47)	(1.87)	(0.31)	(1.94)	(4.48)	(0.79)		[0.08]	[0.16]
	TRANSPORT EQ.	0.01	-0.00	0.05**	0.39	1.24**	-0.55***	-1.22*	-5.84***	-0.86***	0.99	5.30	0.34
		(0.02)	(0.02)	(0.02)	(0.26)	(0.63)	(0.07)	(0.62)	(1.56)	(0.26)		[0.07]	[0.56]
	POST, TELECOMS	-0.12*	-0.01	0.00	0.20***	0.43	-1.22***	2.66***	-12.2***	-2.16***	0.92	5.03	2.51
		(0.07)	(0.04)	(0.01)	(0.06)	(0.52)	(0.21)	(0.86)	(3.26)	(0.63)		[0.08]	[0.11]
	BUSINESS SER.	-0.09*	-0.03	-0.36***	0.33***	-0.59	1.68***	-1.59**	10.5***	-1.33***	0.99	4.67	2.44
		(0.05)	(0.04)	(0.09)	(0.06)	(1.15)	(0.41)	(0.65)	(3.58)	(0.34)		[0.10]	[0.12]
LOW-	FOOD	0.02	-0.02	0.11**	0.29*	-0.42	-0.70***	1.79***	-1.22	0.95***	0.98	5.83	0.01
TECH		(0.02)	(0.02)	(0.05)	(0.16)	(0.40)	(0.09)	(0.30)	(0.85)	(0.12)		[0.05]	[0.91]
	TEXTILE	0.00	-0.01**	-0.04***	-0.08	0.21	0.28***	-0.64*	-6.0272***	0.09	0.99	7.91	2.98
		(0.00)	(0.01)	(0.01)	(0.10)	(0.41)	(0.09)	(0.34)	(0.99)	(0.13)		[0.05]	[0.23]
	WOOD	-0.01**	0.01	0.04**	-0.05***	0.34	-0.02	0.00	1.80***	0.29*	0.98	8.25	0.16
		(0.00)	(0.01)	(0.02)	(0.02)	(0.27)	(0.05)	(0.27)	(0.54)	(0.18)		[0.02]	[0.69]
	PULP, PAPER	-0.03	0.08	0.15**	0.12	4.95*	-0.702**	-2.29	3.28	-1.61	0.97	7.57	1.38
		(0.03)	(0.04)	(0.07)	(0.12)	(2.66)	(0.32)	(1.57)	(2.62)	(0.99)		[0.02]	[0.24]
	RUBBER	-0.01	0.01***	-0.03***	-0.15	0.17*	-0.62***	-3.77***	-0.27**	-0.11	0.96	6.83	2.33
		(0.01)	(0.00)	(0.01)	(0.18)	(0.09)	(0.17)	(0.61)	(0.11)	(0.09)		[0.08]	[0.31]
	NON-MET. MIN.	-0.01	-0.01**	-0.02	-0.10	0.07	0.06	-0.06	1.15	0.31**	0.96	6.58	0.02
		(0.01)	(0.01)	(0.02)	(0.08)	(0.24)	(0.08)	(0.18)	(1.06)	(0.15)		[0.04]	[0.88]
	BASIC METALS	0.13***	0.03**	0.12***	0.34*	0.90	-0.49**	-2.73***	-1.96	-0.47	0.96	14.52	1.74
		(0.04)	(0.01)	(0.04)	(0.18)	(0.65)	(0.23)	(0.74)	(1.62)	(0.38)		[0.00]	[0.19]
	MANUF. NEC	-0.09***	-0.01***	0.03***	0.09***	-0.24*	0.29***	-0.41***	-2.19***	0.46***	0.97	8.07	5.99
		(0.01)	(0.01)	(0.01)	(0.03)	(0.13)	(0.05)	(0.13)	(0.65)	(0.06)		[0.09]	[0.11]
	WHOLESALE		0.01	0.13***	-0.14**	6.08***	0.15	0.18	20.2***	0.22	0.97	6.19	1.44
			(0.03)	(0.03)	(0.06)	(0.87)	(0.14)	(0.88)	(2.98)	(0.47)		[0.05]	[0.23]
	TRANSPORTS	0.01*	-0.05***	0.01**	-0.06	-1.98***	0.22**	-1.88***	-10.2***	-0.42	0.99	4.78	0.16
		(0.00)	(0.02)	(0.03)	(0.09)	(0.22)	(0.09)	(0.51)	(1.65)	(0.36)		[0.09]	[0.69]
	FIN. INTERMED.	0.01	-3.69***	0.04	0.05	0.97	1.46**	1.71**	-5.31	-2.18***	0.98	8.34	0.95
		(0.05)	(0.57)	(0.12)	(0.06)	(0.96)	(0.64)	(0.77)	(3.90)	(0.53)		[0.04]	[0.62]

Note: IV-GMM estimations based on lagged values of RTFP as instruments. HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. R-2=R-squared. K-Paap LM=Kleibergen-Paap (2006) test of under-identification. Hansen J test of over-identification. P-values in brackets. RTFP=industry Relative TFP. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SKI= Medium- and highly-educated workers. UNSK= Low-educated workers. R&D= national endowment of R&D capital. MOS=national intensity of material (broad) off-shoring. SOS=national intensity of service (broad) off-shoring.

Table A3: IV-GMM estimation with external instruments: endowment channel, eq. 7

		RTFP	AVG RTFP	ICT	NICT	SK	UNSK	R&D	MOS	SOS	R-2	K-Paap LM	Han-sen J
HIGH-	CHEMICALS	0.61	-0.37	0.18	-0.70**	-2.14	0.08	0.00	0.06***	-0.01	0.93	5.10	0.11
TECH		(0.39)	(0.39)	(0.23)	(0.34)	(1.39)	(0.24)	(0.24)	(0.02)	(0.01)		[0.08]	[0.74]
	MACHINERY	-1.73	3.60***	-0.15	-1.95***	-3.15***	-0.57	-0.40	-0.01	-0.04***	0.96	4.00	3.02
		(1.06)	(1.22)	(0.32)	(0.56)	(1.05)	(0.39)	(0.34)	(0.04)	(0.01)		[0.14]	[0.08]
	ELECTRICAL EQ.	3.00***	1.73***	-0.03	-10.7***	-11.4***	-7.34***	-0.06	0.07*	-0.04	0.94	8.85	1.59
		(0.45)	(0.63)	(0.39)	(1.15)	(3.41)	(1.081)	(0.69)	(0.04)	(0.02)		[0.07]	[0.66]
	TRANSPORT EQ.	1.57*	-2.46	0.40	-0.42	-4.20***	-0.76)***	-0.96***	0.11*	0.06**	0.96	4.53	0.55
		(0.83)	(2.11)	(0.38)	(0.36)	(1.38)	(0.25)	(0.35)	(0.06)	(0.03)		[0.10]	[0.46]
	POST, TELECOMS	1.76***	0.19	-0.84***	1.02**	6.48***	1.77***	1.81***	-0.02	-0.05	0.85	5.60	0.03
		(0.43)	(0.44)	(0.22)	(0.44)	(1.68)	(0.56)	(0.21)	(0.02)	(0.03)		[0.06]	[0.87]
	BUSINESS SER.	1.12	-1.10	0.55	-0.32	15.3***	0.75	-0.86	-0.09	0.08	0.98	8.11	0.31
		(0.81)	(1.08)	(0.76)	(1.18)	(4.21)	(1.09)	(1.29)	(0.07)	(0.06)		[0.02)	[0.58]
LOW-	FOOD	-0.61	0.16	-0.39	0.82**	-0.043	-1.31	0.56	0.01	-0.01	0.95	6.17	0.06
TECH		(0.67)	(0.93)	(0.39)	(0.33)	(0.55)	(1.26)	(0.41)	(0.03)	(0.01)		[0.05]	[0.81]
	TEXTILE	0.19	1.00*	-0.01	-0.40*	0.47**	-0.47	0.07	-0.03	0.02**	0.99	8.08	4.28
		(0.26)	(0.51)	(0.17)	(0.23)	(0.22)	(0.96)	(0.16)	(0.02)	(0.01)		[0.04]	[0.12]
	WOOD	0.087	0.26	0.26***	-0.31	-0.32**	-0.51	-0.31**	0.05	-0.01	0.97	4.52	0.21
		(0.16)	(0.29)	(0.08)	(0.24)	(0.13)	(0.47)	(0.13)	(0.01)	(0.01)		[0.10]	[0.65]
	PULP, PAPER	-2.88*	4.94**	-0.01	-2.97***	-0.05	0.79	-0.55	0.09***	0.01	0.98	5.37	0.37
		(1.57)	(2.09)	(0.35)	(0.97)	(0.61)	(1.65)	(0.45)	(0.03)	(0.02)		[0.07]	[0.54]
	RUBBER	1.03***	-0.40***	-0.13***	-0.93***	0.49***	-0.52***	-0.56***	0.01	-0.02***	0.96	6.06	2.80
		(0.20)	(0.12)	(0.05)	(0.10)	(0.09)	(0.18)	(0.11)	(0.01)	(0.0)		[0.05]	[0.09]
	NON-MET. MIN.	0.23	-0.31	-0.12	0.18	0.45***	1.014***	0.53***	-0.01	-0.01*	0.96	5.16	2.49
		(0.24)	(0.23)	(0.09)	(0.14)	(0.16)	(0.35)	(0.09)	(0.01)	(0.01)		[0.08]	[0.11]
	BASIC METALS	-0.23	1.59	-0.31	-3.06***	0.04	-3.27***	-0.10	0.05**	-0.01	0.96	5.22	2.81
		(1.18)	(1.18)	(0.22)	(0.41)	(0.28)	(1.20)	(0.43)	(0.02)	(0.01)		[0.16]	[0.25]
	MANUF. NEC	-0.64***	0.66***	-0.17	-0.18	0.13	1.42***	0.66***	-0.01	0.02	0.95	6.64	0.02
		(0.21)	(0.18)	(0.11)	(0.15)	(0.15)	(0.37)	(0.18)	(0.01)	(0.00)		[0.04]	[0.90]
	WHOLESALE	-0.69	-0.19	0.45***	-2.51***	-0.89**	-6.34***	-1.00***	0.07***	0.09***	0.99	7.20	0.20
		(0.70)	(0.79)	(0.15)	(0.44)	(0.36)	(1.31)	(0.20)	(0.02)	(0.02)		[0.03]	[0.65]
	TRANSPORTS	4.57	-1.22	-0.76	1.41	0.83	9.33	1.17	-0.07	0.06	0.95	3.49	1.39
		(5.25)	(3.32)	(0.79)	(3.36)	(1.47)	(6.74)	(1.46)	(0.12)	(0.06)		[0.32]	[0.50]
	FIN. INTERMED.	2.73***	1.24	-0.70	1.74*	-0.62	1.02	1.84*	-0.21***	-0.04	0.88	4.38	0.38
		(0.87)	(0.96)	(0.81)	(1.02)	(0.51)	(2.1)	(1.11)	(0.07)	(0.04)		[0.11]	[0.54]

Note: IV-GMM estimations based on external institutional variables for instrumenting RTFP, NOS_i, MOS_i and SOS_i. HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. R-2=R-squared. K-Paap LM=Kleibergen-Paap (2006) test of under-identification. Hansen J test of over-identification. P-values in brackets. RTFP=industry Relative TFP. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SKI= Medium- and highly-educated workers. UNSK= Low-educated workers. R&D= national endowment of R&D capital. MOS=national intensity of material (broad) off-shoring. SOS=national intensity of service (broad) off-shoring.

Table A4: IV-GMM estimation with external instruments: productivity channel, eq. 11

		NOS_i	MOS_i	SOS_i	SOS_i	AVG RTFP	ICT	NICT	SK	UNSK	R-2	K-Paap LM	Han-sen J
HIGH-	CHEMICALS	-0.03	-0.06	0.03	0.73**	1.30	-1.14**	-1.34***	-1.43	0.48	0.87	1.12	2.25
TECH		(0.02)	(0.07)	(0.07)	(0.33)	(0.84)	(0.55)	(0.27)	(3.45)	(0.33)		[0.77]	[0.32]
	MACHINERY	0.05	-0.00	-0.06	0.61**	1.12**	-0.50	-2.07**	-3.80	-0.016	0.96	4.60	1.41
		(0.05)	(0.06)	(0.04)	(0.29)	(0.55)	(0.31)	(1.05)	(3.69)	(0.55)		[0.20]	[0.49]
	ELECTRICAL EQ.	-0.09	0.09	0.08	2.90***	2.61	-1.17***	-3.86**	-3.72	2.67	0.86	2.29	5.80
		(0.08)	(0.07)	(0.07)	(0.73)	(2.85)	(0.42)	(1.55)	(4.21)	(2.23)		[0.51]	[0.06]
	TRANSPORT EQ.	-0.01	-0.08**	0.09*	-1.69*	2.14**	-0.51***	0.89	-6.09	-1.28***	0.95	6.28	0.30
		(0.05)	(0.04)	(0.05)	(1.00)	(1.06)	(0.18)	(1.34)	(4.47)	(0.42)		[0.10]	[0.86]
	POST, TELECOMS	-0.06	-0.07	0.02	0.10	0.26	-1.04***	2.82	-8.20	-1.66	0.92	2.78	0.58
		(0.06)	(0.06)	(0.02)	(0.24)	(0.79)	(0.37)	(2.25)	(5.86)	(1.02)		[0.25]	[0.45]
	BUSINESS SER.	-0.04	0.04	-0.70***	0.39*	-0.72	2.66***	-1.70	5.90	-2.36***	0.98	1.34	0.80
		(0.15)	(0.04)	(0.17)	(0.20)	(1.81)	(0.45)	(1.9)	(8.22)	(0.70)		[0.51]	[0.37]
LOW-	FOOD	0.01	0.00	0.01	1.02***	0.03	-0.51***	1.77***	-1.57	0.66***	0.96	8.34	0.60
TECH		(0.04)	(0.02)	(0.07)	(0.31)	(0.68)	(0.17)	(0.63)	(1.15)	(0.20)		[0.04]	[0.74]
	TEXTILE	0.01	-0.02**	-0.08***	-0.22	-0.49	0.28***	-0.18	-4.70***	0.37**	0.99	6.43	4.05
		(0.01)	(0.01)	(0.02)	(0.14)	(0.55)	(0.10)	(0.26)	(1.12)	(0.17)		[0.09]	[0.13]
	WOOD	-0.01*	-0.02**	0.03**	-0.02	0.62***	-0.04	-0.58***	0.53***	0.11	0.96	4.00	1.18
		(0.01)	(0.01)	(0.02)	(0.02)	(0.24)	(0.06)	(0.20)	(0.18)	(0.11)		[0.04]	[0.74]
	PULP, PAPER	-0.04	0.10	0.10	0.03	4.04*	-0.86	-1.83**	0.73	-1.41*	0.96	2.87	2.40
		(0.06)	(0.09)	(0.09)	(0.22)	(2.10)	(0.75)	(0.93)	(2.73)	(0.83)		[0.26]	[0.55]
	RUBBER	0.023	0.02***	0.03	0.39***	0.78**	-0.20*	-1.05***	0.93**	-0.38*	0.90	1.29	6.25
		(0.01)	(0.01)	(0.03)	(0.08)	(0.32)	(0.114)	(0.32)	(0.41)	(0.23)		[0.24]	[0.12]
	NON-MET. MIN.	-0.06	-0.02	0.04	-0.13	0.06	-0.24	0.66**	3.38**	0.80***	0.92	2.42	3.74
		(0.05)	(0.01)	(0.03)	(0.11)	(0.21)	(0.20)	(0.28)	(1.48)	(0.28)		[0.53]	[0.01]
	BASIC METALS	0.30***	0.12**	0.07	-0.79	1.08	0.81	-2.58**	-2.67	-1.49	0.86	2.63	0.22
		(0.11)	(0.05)	(0.12)	(0.95)	(1.50)	(0.88)	(1.31)	(2.49)	(0.97)		[0.30]	[0.05]
	MANUF. NEC	0.02	-0.02**	0.02	-0.12	0.86	-0.19	-0.62**	0.74	0.24	0.96	4.74	1.10
		(0.06)	(0.01)	(0.02)	(0.11)	(0.56)	(0.30)	(0.25)	(1.91)	(0.21)		[0.27]	[0.64]
	WHOLESALE	0.15	0.36	0.12	-1.32	-3.52	-0.07	-4.94	-12.7	-1.62	0.57	0.49	0.25
		(0.23)	(0.61)	(0.21)	(1.86)	(5.27)	(1.29)	(5.6)	(15.9)	(3.16)		[0.09]	[0.29]
	TRANSPORTS		0.16	0.10	-0.22	0.39	-0.63	0.61	22.6**	1.84*	0.90	3.45	1.22
			(0.12)	(0.14)	(0.151)	(3.79)	(0.67)	(1.85)	(9.12)	(0.97)		[0.78]	[0.61]
	FIN. INTERMED.	0.08	-1.92	-0.15	-0.16	0.92	1.71***	0.57	3.79	-2.32***	0.82	6.90	5.87
		(0.18)	(1.39)	(0.25)	(0.13)	(2.17)	(0.53)	(1.17)	(5.48)	(0.70)		[0.28]	[0.04]

Note: IV-GMM estimations based on external institutional variables for instrumenting RTFP, NOS_i, MOS_i and SOS_i. HAC standard errors (in parentheses). Country fixed effects and common time dummies are included in all equations. R-2=R-squared. K-Paap LM=Kleibergen-Paap (2006) test of under-identification. Hansen J test of over-identification. P-values in brackets. RTFP=industry Relative TFP. AVG_RTFP=within-country average Relative TFP. ICT= national endowment of ICT capital. NICT= national endowment of non-ICT capital. SKI= Medium- and highly-educated workers. UNSK= Low-educated workers. R&D= national endowment of R&D capital. MOS=national intensity of material (broad) off-shoring. SOS=national intensity of service (broad) off-shoring.